INTERAVIA

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

IN THIS ISSUE

Preview of Farnborough 1959

A Catalogue of the Space Age

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U.S.A.:	$ 1.00
British Isles:	4/6
South Africa:	6 s.
Rhodesia:	6/6
Switzerland:	Fr. 3.50
Germany:	DM 3.50
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VOLUME XIV

No. 9 / 1959

CONVAIR 880 and 600 JET-LINERS... NEW YORK INTERNATIONAL AIRPORT

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First to offer Convair 880 or 600 Jet-Liner service will be TWA, DELTA, TRANSCONTINENTAL (Argentina), REAL-AEROVIAS (Brazil), S.A.S., SWISSAIR, AMERICAN

Volume XIV

INTERAVIA

September 1959

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

PREVIEW OF FARNBOROUGH 1959

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II. Individual Objectives . . . . . E. K. BARNES, GENEVA
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Front cover: *The future in prototype form* . . . Short Brothers & Harland's SC.1 VTOL aircraft, whose principle is soon to be applied to military designs, over its miniature base.

Safety will always be Belgian Air Lines' main goal

The transport of persons and property in absolute safety is the constant concern of the management of the Belgian Air Lines, as indeed it is of any air transport company. The priority of safety over all other considerations is stressed both in the general policy directives issued to the staff and in the establishment and observation of the standards for equipment utilization and the working conditions of aircrews.
This regard for safety has also promoted research within the company itself with the aim of producing new and original solutions to problems concerning the comfort and well-being of passengers.
Such research has resulted in the production by Sabena's technical departments of a swing seat, known as the " Braun seat " after the name of its inventor, one of the company's engineers. This seat, normally upright, moves automatically to a horizontal position when the aircraft is subjected to decelerations above a given value, particularly in the case of a hard landing, and enables passengers to withstand far higher decelerations than formerly.
The seat, which has the approval of the Administration Belge de l'Aéronautique, will equip the Boeing 707-329 Intercontinentals to be delivered to Sabena from December of this year onwards.

SABENA
BELGIAN AIR LINES

This is the
Murphy MR 380
Airborne Tape Reproducer
specified by BOAC
for use in their Boeing 707

The Murphy MR 380 is an airborne unit designed to play standard 2 track ¼-in. pre-recorded tapes over the aircraft Passenger Announcement Equipment. It has been specified by BOAC for their Boeing 707 aircraft to be delivered later this year. Here are the brief facts:

Frequency Response:	Level from 50—7000 c/s NARTB equalised.
Pre-Amplifier:	Plug-in, transistorised unit, removable for servicing.
Tape Transport:	By 28-volt governed motor giving automatic reversal at each end of tape, with manual over-ride for spool changing.
Spools:	7 in. diameter, giving 2 hours playing time at 3¾ ips.
Control:	Remote combined or independent ON-OFF switching and Gain Control. ON-OFF switch incorporates automatic fade in and fade out feature.
Size:	Standard ½ ATR long to ARINC characteristic 539.

The Murphy publication all about the MR 380 is yours for the asking.

keep in touch with murphy

Murphy Radio (Electronics Division), Welwyn Garden City, Herts.

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803, National Press Bldg., Washington 4, D.C.
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Distributors :

Austria	Morawa & Co., Wollzeile 11, Vienna I
Canada	Wm. Dawson Subscription Service Ltd., 587 Mount Pleasant Road, Toronto 12, Ont.
	Edward Company Regd., P.O. Box 98, Station Delorimier, Montreal P.Q.
Eire	Basil Clancy, Cooleevin, Foxrock, Co. Dublin
Finland	Akateeminen Kirjakauppa, Keskuskatu 2, Helsinki
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Uruguay	Humanitas, Colonia 883, Montevideo

Advertising Department, Publishing and Editorial Offices, Subscription Department :

Interavia S.A., 6, Corraterie, Geneva. Telephone: 25 42 34 (five lines). Cables and Telegrams: Interavia-Geneva. Teleprinter: 22 122. Postal Cheque Account: Geneva I 5380.

Annual Subscriptions : U.S.A. and Canada, U.S.$9.00; United Kingdom and Eire, £2.12.6; Commonwealth, £2.12.6; Switzerland, 32.— fr.; Austria, 190.— sch.; Belgium, 370.— fr.; Denmark, 55.— kr.; France, 4200 Fr. fr.; Germany, 32.— DM; Holland, 28.— fl.; Italy, 4640.— L. it.; Japan, U.S. $9.00; Latin American countries, U.S. $9.00; Norway, 57.— kr.; Spain, 450.— pts; Sweden, 40.— kr. All other countries, U.S. $9.00.

Appears Monthly in Four Editions : English, French, Spanish and German

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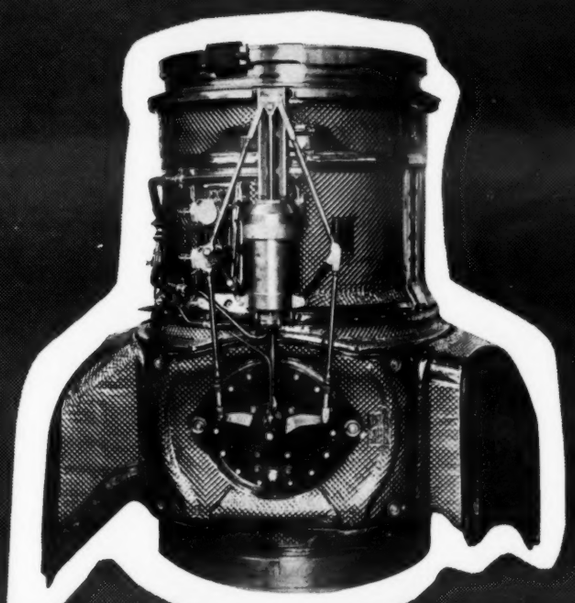

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are now being made by Delaney Gallay Ltd. at lower prices than ever before

What's more, we don't jib at complicated shapes and fittings, as this blanket fitted to the Rolls-Royce thrust reverser for the D.H. Comet proves.

Our wide experience has enabled us to develop a revolutionary and exclusive method of manufacture that we sincerely believe will enable us to tackle anything.

WE ALSO DESIGN AND MANUFACTURE

High pressure fuel-cooled oil coolers for high performance gas turbine engines. This unit is used in the Armstrong Siddeley Sapphire S.A.7.

We shall be delighted to help you with your problems in any of these fields.

Heat exchangers for many purposes in both aluminium alloy and stainless steel. This particular example is for the Vickers Vanguard's anti-icing system. Similar units are being supplied for the Fokker Friendship, the Bristol Britannia, the Armstrong Whitworth Argosy, the Vickers Viscount and the Handley Page Herald.

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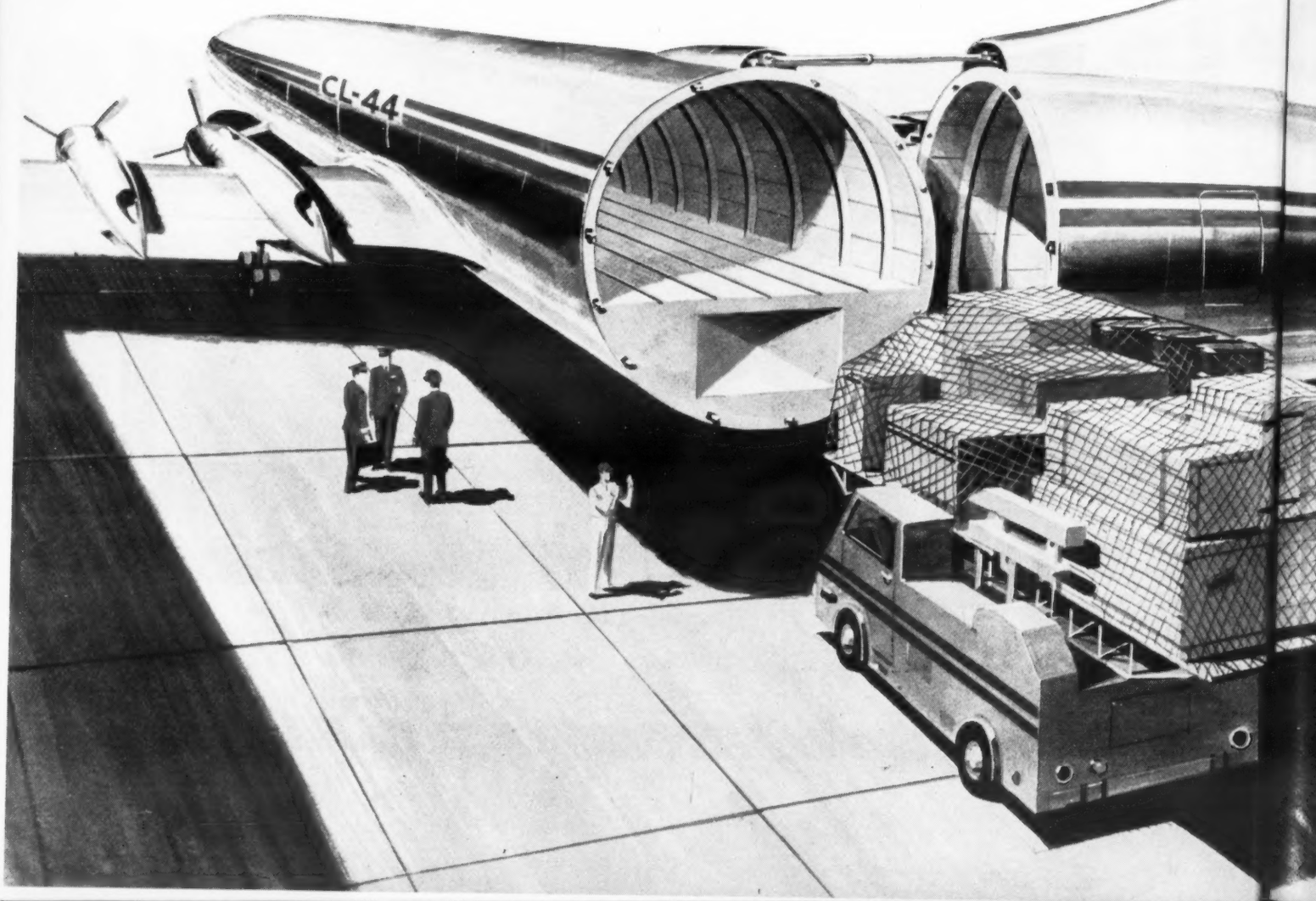
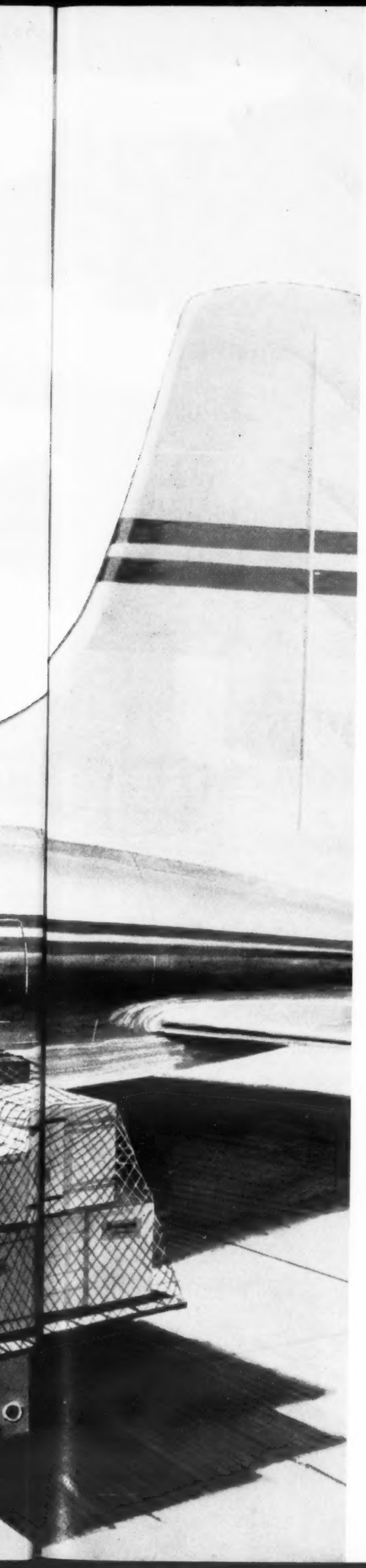
We are exhibiting at Farnborough on Stands Nos. 8 and 268

The Breakthrough Air Freighter that smashed the cost barrier!





CANADAIR JET-PROP CL-44

...the first aircraft designed specifically for the air cargo industry

The jet-prop CL-44 was designed specifically to meet the immediate requirement for an aircraft that would significantly lower the cost of cargo movement.

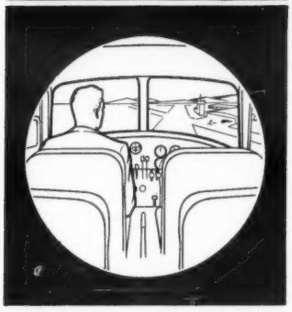
In this highly important role, the Canadair CL-44 breaks through the transportation cost barrier and will revolutionize the whole air cargo market. It provides direct operating costs of less than 4¢ a ton mile and breakeven load factors as low as 28%, which are both lower than those of any other aircraft anywhere in the world.

The swing-tail CL-44 is already in production for the largest air cargo carriers in the world—Seaboard & Western Airlines Inc. and The Flying Tiger Line Inc.

- Payload—64,000 lbs. • Range—3,000 mi. • Speed—400 mph
- Engines—4 Rolls-Royce Tyne 12 • Cubic capacity—7,391 cu. ft.
- Floor loading—300 lbs. per sq. ft. • Passengers—up to 183
- Span—142 ft. • Length—138 ft. • Cabin length—98 ft.
- Gross weight—205,000 lbs. • F.A.A. takeoff field length—7660 ft.

The Canadair CL-44 is also available as a passenger or as a convertible passenger/cargo aircraft.

CANADAIR
LIMITED, MONTREAL
the Canadian Subsidiary of
GENERAL DYNAMICS CORPORATION



Aero Commander means business

Any way you look at it,
here is Leadership!

To you, Aero Commander leadership means going farther, faster and more easily. It means superior performance and dependability.

Aero Commander's high wing design is a factor of leadership: greater stability, more comfort. It means, too, that you step into this airplane as easily as you enter your car! You lift luggage just knee-high into the ample compartment. And there's panoramic visibility from inside the cabin.

Any way you look at it, this aircraft means business! Your distributor will show you more reasons for Aero Commander's leadership. Ask him, today.

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AERO DESIGN & ENGINEERING CO • BETHANY, OKLAHOMA

LOOK TO THE LEADER

WRITE FOR BROCHURE

FERRANTI

Important contributions to the Aircraft Industry

Electronic equipment by which the 'Bloodhound' missile tracks and intercepts its target. Ground equipment for missile assembly, test and repair. Operational launch control equipment 'Bloodhound' is in full production for the defence of Britain and for the Royal Swedish Air Board.

AIRPASS Radar Fire Control System in production for the English Electric 'Lightning' Aircraft.

Automatic Bombing and Survey System, Machine Tool Control, Potentiometers and Transformers.

Electronic Computers and Data Processing Systems for aircraft design and commercial applications in the aircraft industry.

Gyroscopes, Transistorised Control Units and Static Electrical Equipment.

Silicon Semiconductor Devices for flight systems, aero engine controls, aircraft power supplies, radar systems, guided missiles and aircraft instruments.

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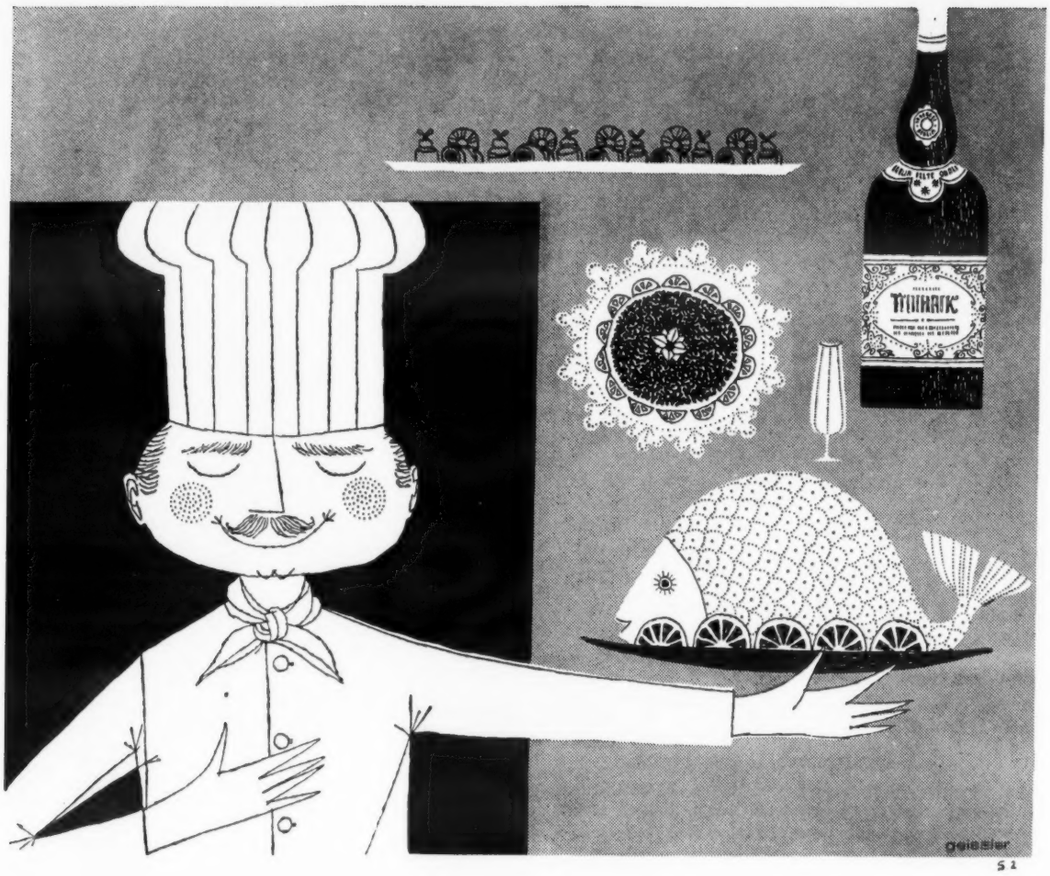

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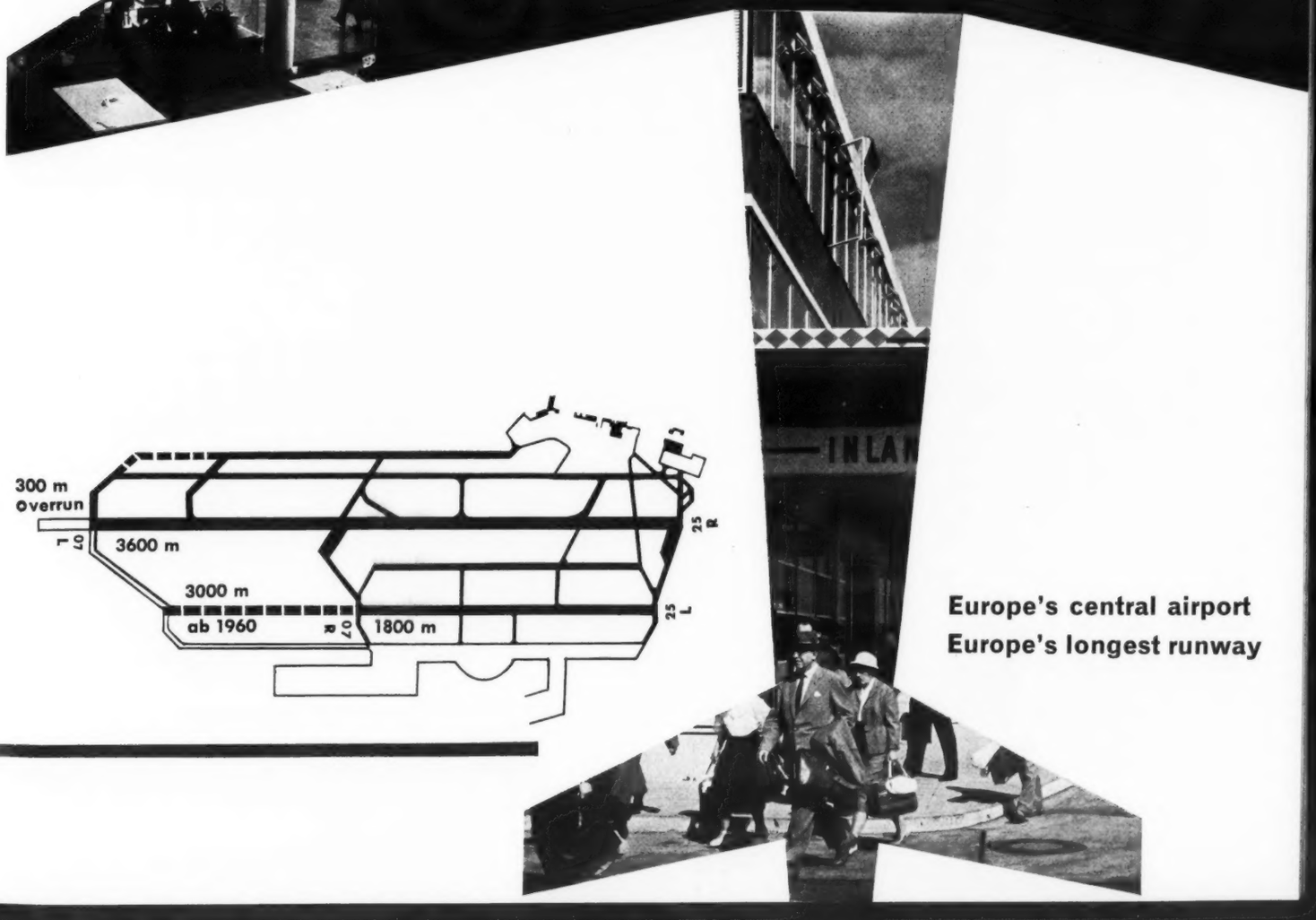
LUFTHANSA THE FINEST SERVICE ON BOARD

1018

Frankfurt/Main Airport

is ready for intercontinental jet traffic with its 13,000-foot runway



Europe's central airport
Europe's longest runway

Caravelle

is in service on the European network of AIR FRANCE

PARIS-MILAN : 1 hr 20 min flight
PARIS-ROME : 2 hr flight
PARIS-ATHENS : 3 hr 50 min flight
PARIS-ISTANBUL : 5 hr flight

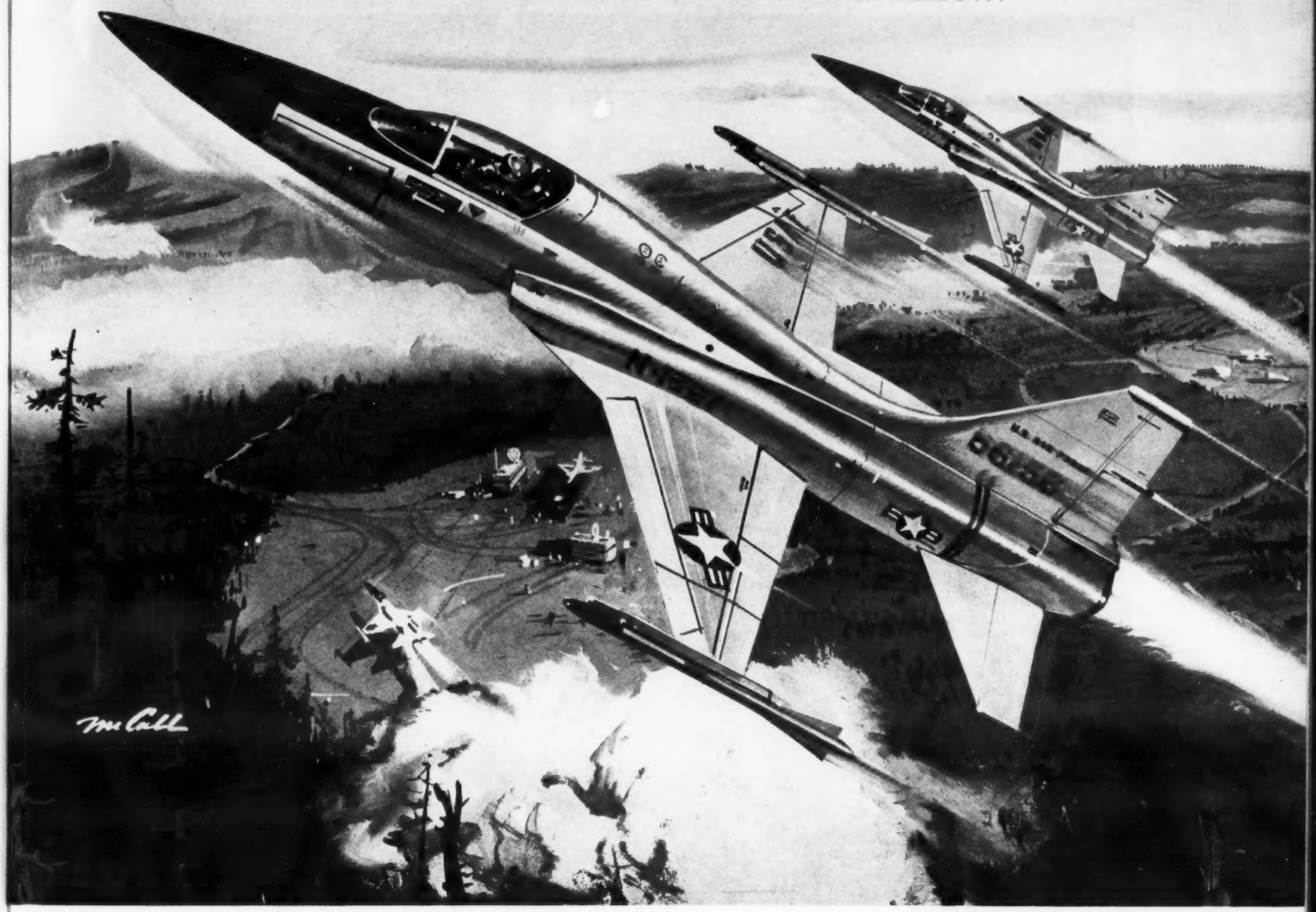
TOTAL SILENCE AT 500 MPH

AIR FRANCE

THE WORLD'S LONGEST ROUTE NETWORK

A FLEET OF 24 CARAVELLES WILL BE PROGRESSIVELY INTRODUCED ON THE WHOLE OF AIR FRANCE'S EUROPEAN NETWORK
CONSULT YOUR TRAVEL BUREAU OR THE NEAREST AIR FRANCE AGENCY. RESERVE YOUR SEAT IN TIME—TODAY

N-156F, DESIGNED SPECIFICALLY TO MEET FREE WORLD DEFENSE NEEDS . . .



Northrop's "Freedom Fighter" with General Electric J85 Engines will assure first line defense at low cost

Northrop Corporation's N-156F fighter represents a new approach to maximum air combat effectiveness at practical procurement and maintenance costs. A major factor in the success of this new approach is the development of the J85 turbojet engine by General Electric, U.S.A.

Rated at 2500 lbs dry thrust and 3850 lbs reheat thrust, the lightweight J85 provides for significant savings in airframe weight . . . corresponding reductions in airframe costs.

The J85's outstanding performance has been confirmed by an extensive test program that has already exceeded 5000 hours. This total includes highly successful flight tests aboard the N-156F, its sister, the T-38 "Talon", USAF trainer, North American's T-39 utility transport, and McDonnell Aircraft's "Quail" decoy missile.

With production engines now being delivered for the "Quail" program, General Electric's J85 has already begun its important role in free world air defense.

Progress Is Our Most Important Product

GENERAL ELECTRIC

U.S.A.

N-156F WILL HAVE MACH 2 SPEED CAPABILITIES with a more powerful General Electric J85 engine now being programmed. To receive a new J85 brochure, write to General Electric Co., Sect. 233-26, Schenectady 5, N.Y., U.S.A.

ARMY
ARMY
ARMY

Vertol selected to build new 2-3 ton transport helicopter

Vertol has been selected by the U.S. Army to develop a new 2-3 ton capacity helicopter, destined to write a new page in the mobility book of today's fast striking forces. This multi-turbine powered vehicle (Army designation the YHC-1B Chinook) is a growth version of the company-developed Vertol 107 family prototype.

The all-weather, day-night YHC-1B will be capable of performing such varied missions as redeployment, reinforcement, attack and pursuit. In a logistical role, the aircraft could transport missiles, nuclear warheads and general cargo, and evacuate casualties. Its unobstructed 30-foot long payload compartment, with a straight-in rear loading ramp that can be left partially or completely open or removed entirely to transport extra-length cargo, speeds the entry and discharge of men and materiel . . . and facilitates in-flight parachute or free-drop delivery for special missions.

The YHC-1B will not only be able to air-lift tactical units capable of completing assigned combat missions, but provide vitally needed mobility within the combat zone. This mobility is requisite in the concept of limited conflicts and, in addition, provides an important offensive and defensive weapon against nuclear attack. In a nuclear situation, the YHC-1B could provide the means for the prompt concentration of troops for attack and their equally rapid dispersion to negate effective retaliation.

All the proved advantages of tandem-rotor helicopters as pioneered by Vertol, will be inherent in this newest Army air vehicle. Large center of gravity range that permits indiscriminate seating and regrouping in flight • Low rotor downwash velocity • Excellent towing characteristics • Rotors high on airframe to permit landing in wooded terrain • Excellent hovering characteristics under varied conditions • Pilot seats low in airframe for ease in judging clearances • Easy maintenance.

Vertol's years of research in the VTOL-STOL field, personified in the YHC-1B, assure our Pentomic army the mobility, speed, flexibility and freedom from terrain that are among the nation's most potent weapons in preventing aggression.

Engineers: *Join Vertol's advanced engineering team*

VERTOL *Aircraft Corporation*

MORTON, PENNSYLVANIA

SUBSIDIARIES: ALLIED RESEARCH ASSOCIATES, INC., BOSTON, MASSACHUSETTS, VERTOL AIRCRAFT CO. (Canada) LTD., ARNPRIOR, ONT.

LOOK AT THE FACTS ABOUT THE REPUBLIC F-105

- **Republic's F-105 is the only <u>all</u>-weather strike fighter on order for Europe by the U.S. Air Force.**
- **Republic's F-105 is the only truly complete Weapons System designed for Europe's specific tactical needs.**
- **Republic's F-105 is "the world's most powerful one-man aircraft."**

These facts prove the F-105's air superiority and its ability to accomplish "the mission". To help NATO with its mission . . . there is Republic's "Mission Plan" . . . establishing a prime source of supply in Europe through the production of this supersonic, nuclear armed jet by various industrial firms throughout NATO countries.

REPUBLIC AVIATION

FARMINGDALE, NEW YORK, U. S. A.

Designers and Builders of the Incomparable THUNDER-CRAFT

Only the VANGUARD

paces pure jets at turbo-prop cost on short and medium haul routes

London-Hamburg
470 miles in 1 hour 13 minutes at 386 m.p.h. (a route record), tailwind 17 m.p.h.

Hamburg-London
1 hour 21 minutes (including a G.C.A. approach), headwind 25 m.p.h.

London-Brussels
230 miles in 45 minutes at 309 m.p.h., headwind 5 m.p.h.

Brussels-London
45 minutes, wind zero

London-Rome
955 miles in 2 hours 27 minutes at 386 m.p.h. at I.S.A. + 5°C. Wind zero (3 minutes faster than current pure jet schedule).

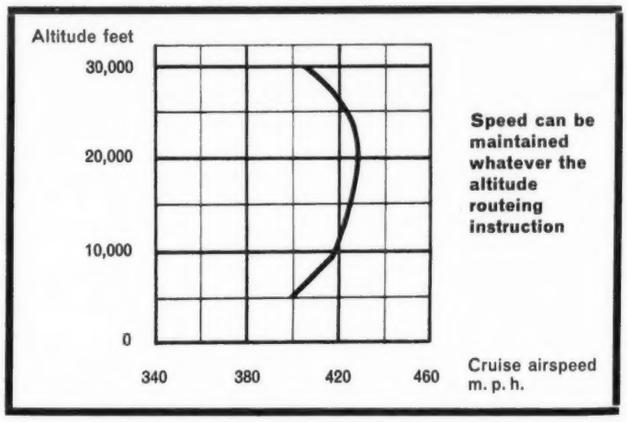
Rome-London
2 hours 35 minutes (including 10 minutes in the stack), headwind 12 m.p.h.

London-Paris
224 miles in 41 minutes. Winds light to zero.

Paris-London
54 minutes (A.T.C. delays), headwind 5 p.m.h.

PROOF of Vickers' claim that the VANGUARD would achieve pure-jet block times on short and short/medium routes has now been firmly established.
The times given in the table for stages up to 955 miles were achieved on commercial routes under actual route operating conditions. On the London-Rome flight the VANGUARD's time was *3 minutes less than the current four-engined pure jet schedule.*

Jet-competitive speed comes from the VANGUARD's ability to utilise a realistic and genuine cruise speed of over 400 m.p.h. at all altitudes between 5,000 ft and 30,000 ft. This is clearly shown on the cruise performance chart. A further result of this speed/height flexibility is a very low cost differential between routeings at widely differing altitudes. On a 500-mile trip, for instance, the difference between routeing at 10,000 ft and 20,000 ft (the most economical) is only $44. On the Rome-London flight the ten minutes' stacking over Epsom—due to heavy traffic—would have cost $70 with a pure jet. With the VANGUARD which stacked low, the cost was only $40.
On short and medium haul only an exceptionally fast jet could beat VANGUARD block times. No jet can compare with its remarkable operating economics. No jet can compare with its cheap-fare potential.



Of all the airliners only the Vanguard has all these features

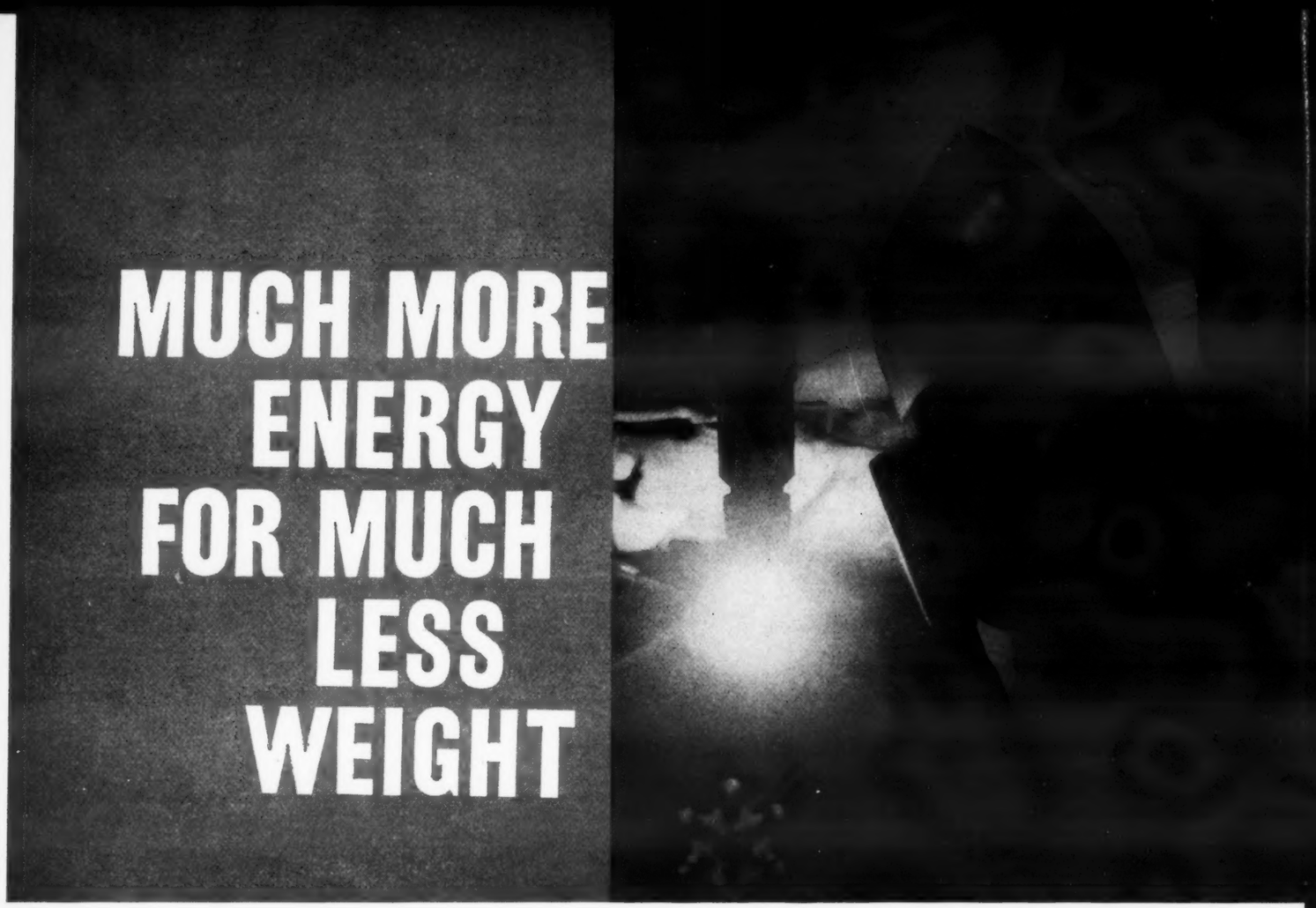
425 m.p.h. cruising. Freight capacity 10 tons at normal densities. Full routeing and A.T.C. flexibility. Can use normal existing airfields. Quick turn-round. No airfield noise problems. Ten years' unique Vickers/Rolls-Royce turbo-prop experience... *And it is 'Viscount' quiet.*

VICKERS VANGUARD

FOUR ROLLS-ROYCE TYNE TURBO-PROP ENGINES

The airliner with the biggest profit potential ever offered to the operator

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY



MUCH MORE ENERGY FOR MUCH LESS WEIGHT

New Bristol Aerojet process produces gas storage vessels of great strength—high capacity—exceptionally low weight

High-pressure gas storage bottles have become an essential part of aircraft and guided missile systems. They provide a compact and efficient method of storing energy.

Bristol Aerojet, specialists in the design and manufacture of high tensile steel welded components, have developed a very advanced range of pressure vessels. Operating with great reliability at high stress levels, this new design provides unusually high energy storage capacity for exceptionally low weight.

Made of chrome molybdenum steel, the vessels are welded by the argon shielded tungsten arc process and heat treated to a minimum ultimate strength of 75 tons per sq in. All welds are examined several times during manufacture, both visually and radiographically and are subjected to the same stress as the parent material.

Bristol Aerojet pressure vessels are made in many specified shapes and range from 100 to 2,000 cu in capacity. When compared to forged vessels they show a weight saving of at least 5 lb per 500 cu in. and as much as 50%.

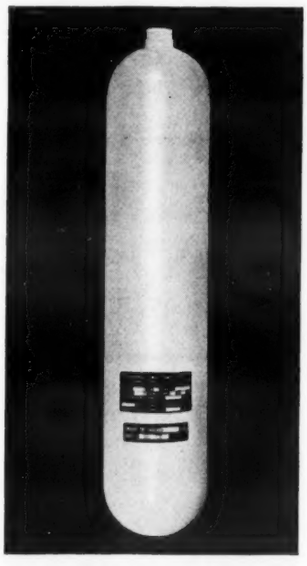
Bristol Aerojet Pressure Vessels Specified For Trans Canada Vanguards

Trans Canada Airlines have chosen Bristol Aerojet pressure vessels for the Elliot escape chutes in their 20 Vanguards.

Other companies supplied include:

Bristol Aircraft Limited
Bristol Siddeley Engines Limited
De Havilland Aircraft of Canada Limited
De Havilland Propellers Limited
Walter Kidde Co. Limited
British Messier Limited
The Pyrene Co. Limited
A. V. Roe & Co. Limited
Saunders-Roe Limited
Short Bros. & Harland Limited
Vickers-Armstrongs Limited

If you would like further information, about Bristol Aerojet pressure vessels or high tensile steel welded components, please write to:—The Sales Manager, Bristol Aerojet Limited, Banwell, Weston-Super-Mare, England. Telephone: Banwell 250.



Type 3135 Pressure Vessel
Cylindrical (525 cu in.)

Design ultimate pressure	5000 psi
Maximum inflation pressure	2500 psi
Free gas volume	1470 litres
Weight	12 lb

ARB approved

Suitable for CO_2 fire extinguishers and pneumatic systems.

BRISTOL AEROJET

INTERAVIA

AIR LETTER

reports...

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British European Airways finally signed a revised £29,000,000 contract with the Aircraft Manufacturing Company (Airco) on August 12th, for the purchase of twenty-four D.H.121 three-jet airliners. The corporation also took an option on a further twelve. In its revised design the D.H.121 will have either a 75-passenger first and tourist class layout or a 90-passenger economy class layout. Powerplant will be three Rolls-Royce RB.163 by-pass engines, each of 10,000 lb thrust and tail-mounted. The aircraft will have a cruising speed of over 600 m.p.h. and a range of up to 1,200 miles with full payload. First flight is scheduled for 1961, and BEA expects first deliveries by early 1963.

●

Pan American World Airways has ordered twelve Lockheed *Super Hercules* long-range turboprop freighters. The order is valued at $60,000,000, and deliveries are scheduled for early 1962. At the same time an option was taken on a further twelve aircraft.

●

Swissair and SAS have been considering the possibility of changing the Swissair order for five Convair 880 jet transports to the newer Convair 600 model. The latter, equipped with four General Electric CJ805 series turbofan engines, will offer the carriers increased payload, higher speeds and reduced specific fuel consumption. During its works testing, now almost completed, the Convair 880 has achieved or surpassed all design performance figures, but Swissair and SAS believe the Convair 600 would be more suitable for their route networks.

●

British Overseas Airways Corporation has at last received the long-awaited authority to operate a round-the-world service through Tokyo. Twice-weekly flights London-New York-San Francisco-Honolulu-Tokyo by *Britannia* turboprop aircraft were scheduled to begin on August 22nd and will link with the *Comet 4* service via Hong Kong, India and the Middle East.

●

The United States and France signed a new air agreement early in August containing a number of amendments to the earlier agreement concluded in 1946 but revoked by France in 1958. The main concession granted to France is the right to fly a Polar route to either San Francisco or Los Angeles. In addition, France gets a second new route from New Caledonia and Tahiti to Honolulu and either Los Angeles or San Francisco. The United States will have a parallel Pacific route. Finally, France now has traffic rights at Anchorage, Alaska on its Polar route to Tokyo, while the United States has similar rights at both Marseilles and Nice on the No. 2 route USA-Spain-Italy-Middle East-Far East.

●

Ceskoslovenske Aerolinie and Air-India International have signed a pool agreement for the operation of regular services between Czechoslovakia and India. CSA was scheduled to open a weekly Tu-104 service from Prague via Cairo and Bahrein to Bombay on August 29th, while Air-India has been flying to Prague since 1956.

●

Aeroflot is at present operating some 1,900 aircraft—1,700 of them piston-engine types—on its many kinds of service. Of the two hundred turbine-powered aircraft, roughly one hundred are reported to be Tupolev Tu-104As, while the remainder are Tu-104Bs, Ilyushin Il-18s and Antonov An-10s and An-10As. The 85-seat Antonov An-10 has been operating the Moscow-Simferopol route since the end of July, taking 2 hours 15 minutes for the 750-mile journey. It is also shortly to be introduced on the routes from Moscow to Rostov, Stalino and Kharkov and used in Siberia and the Far East. Since early August the Ilyushin Il-18 has replaced the Il-14 in service between Moscow and Frunze, capital of the Soviet Republic of Kirghizia. Frequency is three services a week, and flight time for the 2,050-mile stage is five hours.

●

Alitalia's expansion programme calls for the opening of services to Canada, the Far East and Australia. The Alitalia network in Europe, Africa and the Middle East is to be progessively handed over to jet aircraft, and financing of the purchase of eight medium-haul jets has been assured by the Istituto per la Ricostruzione Industriale and bank loans. The company has not yet announced which type of jet is to be ordered, but it is strongly rumoured that it may be the Sud-Aviation *Caravelle*.

●

Capital Airlines has introduced a commuter ticket system for travel on services between Minneapolis/St. Paul and Chicago, and American Airlines now has a similar system on the heavily-travelled routes linking Boston, New York and Washington. Other carriers are expected to follow suit. Commuter tickets are issued in booklets of ten, containing either ten one-way tickets or five separate round-trip tickets. Having made his reservation by telephone, the traveller enters flight number, date and time on the coupon in the booklet. Response so far has been excellent, and the system will probably be extended to other routes.

●

Rhein/Main airport, Frankfurt will inaugurate its newly extended runway (11,810 feet) on September 5th, with the take-off of a Boeing 707. The second main runway is to be lengthened from 6,000 to 10,000 feet next year, and a new terminal facility will be built after 1961. Total cost of the development programme at Frankfurt from 1956 to 1961 is estimated at DM 70,000,000.

●

Canadair Limited has received the $91,500,000 contract to build the airframes for 200 Lockheed F-104G *Starfighters* for the Royal Canadian Air Force (RCAF designation CF-111). The contract, for the J79 engines, valued at $80,000,000, was awarded to Orenda Engines Ltd. in July, while the licence manufacturer of the fire control system has not yet been announced. Total value of the 200 F-104Gs, excluding weapons, will be about $240,000,000.

●

Boeing Airplane Company delivered the 300th KC-135 jet tanker to the U.S. Air Force's Strategic Air Command early in August. Orders announced to date total 426, with additional numbers under negociation.

●

Friedrich-Wilhelm Seekatz, 72, at present employed at Heinkel, celebrates his 50th anniversary in aviation on September 6th. He began as an assistant to Professor Reissner (who was financed by Professor Junkers) at Aachen Technological Institute, where he worked hard to remove the "bugs" from a 50 h.p. 16-cylinder Antoinette aero engine—wich already used fuel injection. In 1913 he flew from Berlin-Johannisthal to Villacoublay. Between the two wars he sold aircraft for Fokker.

●

The German Aircraft Industry's 1960 Air Show will be held from April 23rd to May 3rd at Hanover-Langenhagen Airport, to coincide with the Hanover Trade Fair. In future the show will be held every second year, alternating with the Paris Air Show.

●

Claude Grahame-White, pioneer aviator, aeronautical engineer and author, died at Nice on August 19th, two days before his 80th birthday. He was the first Englishman to be granted a certificate of proficiency as an aviator (1909) and also launched the first British flying school (1909). He was the founder of the Grahame-White Aviation Company (subsequently to develop and own London Aerodrome at Hendon), and was the author of many works on aviation subjects.

From the Farnborough Catalogue

• **Aircraft Furnishing Ltd.,** London : Development, production and installation of a wide range of passenger seats, including a double seat model (as installed in the Avro 748 mock-up and the Fairey *Rotodyne)* which is on show for the first time at this year's SBAC display. Also new is the triple "Flyweight" seat, featuring both fixed and reclining backs, to be exhibited on Latex Upholstery Ltd.'s stand. This seat, stressed for accelerations up to 9 g, weighs only 48 lb.

• **Airmed Limited,** Harlow : *Airlite* headsets, microphones and oxygen masks for pilots, as used by BOAC, SAS, Hunting Clan, Air Charter, Aerolíneas Argentinas ; *Simplite* headsets and microphone booms, to be shown for the first time ; *Unilite* single telephone headset.

• **Air Trainers Link Limited,** Aylesbury : A wide range of flight simulators, including a model of a Comet 4B simulator to be supplied to British European Airways.

• **Avica Equipment Limited,** Hemel Hempstead : Tubes and pipes for aircraft construction ; ground support equipment for aircraft and guided missiles.

• **Beaufort Company, Birkenhead** (Division of Frankenstein & Sons Ltd.) : Automatically inflatable lifeboats, in versions with up to 26 seats, as ordered by Qantas and TEAL. These dinghies are fitted with radar reflectors.

• **G. & E. Bradley Limited,** London : Performance monitor Type 10166 for TACAN airborne equipment ; research and production in the electronics field.

• **British Oxygen Aro Equipment,** Harlow : Servicing and overhaul of liquid and gaseous oxygen equipment and associated airborne and ground equipment. — Liquid oxygen for pilots : liquid oxygen and nitrogen for guided weapons ; equipment for storing and handling liquid oxygen, pressure release units, regulators and valves for liquid oxygen equipment ; liquid nitrogen explosion suppression systems.

• **British Timken Limited,** Duston and Daventry : Different types of conical roller bearings and ball bearings.

• **CIBA (A.R.L.) Limited,** Duxford : *Araldite* epoxy resins for casting high-grade insulation, impregnation of electrical windings and other components, preparation of glass fibre laminates etc. ; examples of *Araldite* tools and structures ; metal bonding processes ; *Redux* adhesive for metal bonding ; *Aeroweb* metal honeycomb.

• **Cossor Radar & Electronics Limited,** Harlow ; Secondary radar transponders (SSR. 1251) as ordered by BOAC for its Boeing 707s ; CR.787 medium-range S-band airport surveillance radar (stationary and mobile versions), with MTI and circular polarization ; windfinding radar Type 353 for calculating wind speeds by continuous tracking of balloons ; CRD. 23 radar B-scope ; waveguide kits.

• **The Decca Navigator Company Ltd.,** London : Decca/Dectra navigation system, Decca Navigator Flight Log etc.

• **Decca Radar Limited,** London : D.A.S.R.1 airport surveillance radars as recently ordered by the Swedish Civil Air Board, ready for installation at Stockholm and Göteborg. A D.A.S.R.1 will also be installed later at Malmö. Windfinding and weather radars (the Météorologie Nationale has provided its main meteorological stations in France and the French Community with these equipments). Type 424 airfield surveillance radar with variable polarization for suppressing or mitigating rain and snow returns.

• **Delaney Gallay Limited,** London : Insulating panels ; high-pressure fuel-cooled oil coolers for gas turbines ; aluminium alloy or stainless steel heat exchangers.

• **Ekco Electronics Ltd.,** Southend-on-Sea : Fully transistorized airborne weather radar with an installed weight of only 56 lb and three main component units : display, transmitter-receiver and 24-inch aerial. Range is 150 miles.

• **The English Electric Company Ltd.'s** Aircraft Equipment Division, Bradford : Brushless alternators and constant speed units for aircraft power supplies.

• **Electro-Hydraulics Limited,** Warrington : Undercarriages and hydraulic and pneumatic systems, pumps, valves, power-boosted aircraft control systems. *Victor* undercarriage retracted and extended ; hydraulic selectors and hydraulic components for aircraft and guided weapons.

• **Elliott-Automation Limited,** London : 21 Series VHF communication and VOR/ILS navigation equipment, including the lightweight E-TA-21 transmitter and E-RA-21A receiver ; E-RDR-1D airborne weather radar. Also fuel flowmeters, electronic test equipment and air data systems.

• **Ferranti Limited,** Hollinwood : Fire control equipment for the *Bloodhound* guided missile ; ground equipment for assembly, inspection and overhaul of guided missiles. On show for the first time will be the *Airpass* radar fire control system in production for the English Electric *Lightning*. Also displayed will be electronic computers and data processing systems ; gyroscopic systems ; transistorized control systems ; silicon semi-conductors for flight directors, engine controls, aircraft mains, radar systems.

• **Firestone Tyre & Rubber Co. Ltd.,** Brentford : A wide range of aircraft tyres, including the 46 × 16 model with a new type of profile particularly suitable for high taxiing speeds, as developed for the Boeing 707.

• **Flight Refuelling Limited,** Blandford : Pressure refuelling systems ; in-flight refuelling systems.

• **The Goodyear Tyre & Rubber Co. (Great Britain) Ltd.,** Wolverhampton : Hi-Lander tyres with high resistance to tear, flaking etc., reinforced with triple-tempered nylon fabric.

• **Graviner Manufacturing Co. Ltd.,** London : Airborne fire protection systems ; thermostats, thermostatic cut-off switches, explosion suppression systems and temperature controls.

• **Heenan & Froude Limited,** Worcester : For the SBAC Display this year details are given of a new jet engine test stand recently ordered by Rolls-Royce on behalf of Aerolineas Argentinas. This equipment was initially designed to take the *Avon* engine, but is suitable for testing jets of up to 30,000 lb thrust.

• **High Duty Alloys Ltd.,** Slough : Forgings in *Hiduminium,* steel, titanium and *Nimonic* alloys.

• **Imperial Chemical Industries Ltd.,** London : The Metals Division is showing for the first time two new titanium alloys, " titanium 230 " and " titanium 679 ". The former is a titanium/copper alloy with a minimum tensile strength of 32 tons/sq.in., which can be brought up to 45-53 tons/sq.in. after age-hardening. " Titanium 679 ", an alloy containing tin, zirconium, aluminium, molybdenum and silicon, is highly creep-resistant, and can withstand short-period stresses up to 52 tons/sq.in.

• **Joseph Lucas (Gas Turbine Equipment) Ltd.,** London : quick-release couplings for use in hydraulic, fuel and lubricating systems ; HOD hydraulic pumps (operating temperatures —55°C to +90°C ; pressures of 3,000 p.s.i.) ; fuel pumps and flow control systems.

• **Martin-Baker Aircraft Co. Ltd.,** Higher Denham, Uxbridge : Mark 4 BS fully automatic ejection seat, as installed in the English Electric P.1B *Lightning* fighter. This seat is capable of ejection from ground level and at speeds from 80 knots upwards.

• **Murphy Radio Limited,** Electronics Division, Welwyn Garden City : Type MR 380 airborne tape reproducer to be installed by BOAC in its Boeing 707s. The MR 380 will play back ¼" standard twin-track tape over the passenger announcement equipment at frequencies between 50 and 7,000 c/s ; it is powered by a 28-volt electric motor, and tape transport is automatically reversed at the end of each track. A manual switch is provided for changing the tape. Also exhibited will be leader cable equipment for automatic landing systems and remote control equipment.

• **Marconi's Wireless Telegraph Company Ltd.,** Chelmsford : Complete radar systems for civil and military applications, including type AD 2300 Doppler Navigator ; S 264 surveillance radar ; SNW 51 meteorological radar ; future position indicator (FPI) ; PPIs ; type AD 308 airborne teleprinter receiver etc.

• **Normalair Limited, Yeovil:** Air conditioning plants for aircraft cabins ; lightweight oxygen apparatus ; accessories for atomic power stations.

• **Plannair Limited,** Leatherhead, Surrey : Compressors with several stages ; propeller blowers and axial flow blowers, including blowers fitted with a new silencing device.

• **The Plessey Company Ltd.,** Electronic and Equipment Group, Ilford : Type PVR 500 receiving terminal for dual diversity radio teleprinter (frequency range 2 to 30 Mc/s), particularly suitable for regional point-to-point connections between telecommunications and meteorological stations and airports etc. ; UHF ground-to-air and air-to-air communications equipment working on 1,750 channels. A new exhibit on Plessey's stand will be a 4 kVA constant speed alternator ; also shown will be the ARC-52 UHF transmitter-receiver operating in the 225 to 339 c/s range, also with 1,750 channels, any of which can be selected within three seconds.

• **Redifon Limited,** Crawley : Flight simulators and trainers for *Avon-Sabre,* Bristol *Britannia,* English Electric *Canberra,* de Havilland *Comet,* Vickers *Viscount* and *Vanguard,* SE.210 *Caravelle* etc.

• **Rotax Limited,** London : Complete electrical aircraft systems ; actuators and igniters for aircraft engines ; generators ; transformers and rectifiers, converters, etc.

• **Rotol Limited,** Gloucester : Propellers, including four-blade propellers for the Fairey *Rotodyne* commercial VTOL aircraft ; Rotol is also supplying the reduction gears for the Napier *Eland* turbines, together with r.p.m. and power controls. Rotol propellers are also standard equipment for the Vickers *Viscount,* the Fairchild F-27, the Grumman *Gulfstream,* the Armstrong Whitworth *Argosy* etc.

• **Standard Telephones and Cables Limited,** London : High-precision frequency-modulated radio altimeters as used in fully automatic blind landing systems ; STR. 23/34/35/36 transistorized VHF/ILS/VOR radio and navigation equipment, as specified by BEA for its *Vanguards* and *Comets ;* type SLA 3B2 precision approach radar and its mobile version SLA 3B1 (the latter now in production for the RAF) ; SA.10 transistorized audio distribution and intercommunication equipment etc. STAN 7-8 ILS ground equipment in production for the British Ministry of Transport and Civil Aviation ; STAN 7-8-9 equipment has been ordered by Radio Switzerland Ltd. for Zurich airport and by the Régie des Voies Aériennes for Brussels airport.

• **Thermionic Products (Electronics) Ltd.,** Hythe, Southampton. multi-channel magnetic recording equipment, in particular a new transistorized equipment with a capacity of up to 20 channels.

• **Ultra Electric Limited,** London: The Special Products Division will be showing a type UE.91 engine condition analyser for recording and displaying information on engine temperature and vibration. Also shown will be a crash position indicator (CPI) based on the well-known SARAH search and rescue and homing equipment.

• **The Walter Kidde Company Ltd.,** Northolt, Greenford : On view for the first time will be a polyester resin radome manufactured by a new process ensuring accuracies of 0.001 in. on wall thickness and 0.004 in. on diameter. Not only is the new method more accurate, but also considerably cheaper than existing processes. Also on show will be a passenger emergency oxygen system for civil transports and a new type of mask.

• **Wilmot Breeden Limited,** Birmingham : Manufacturing methods for producing tubes, elbow pipes, conduits, valves and bearing housings from chrome nickel alloys; cold-working (drawing and rolling) of cylindrical housings ; new processes for forming cones and conical tubes. Items on show include a guided missile cone of 0.1" ± 0.005" sheet thickness, and hollow blades and stator blades for the Rolls-Royce *Tyne.*

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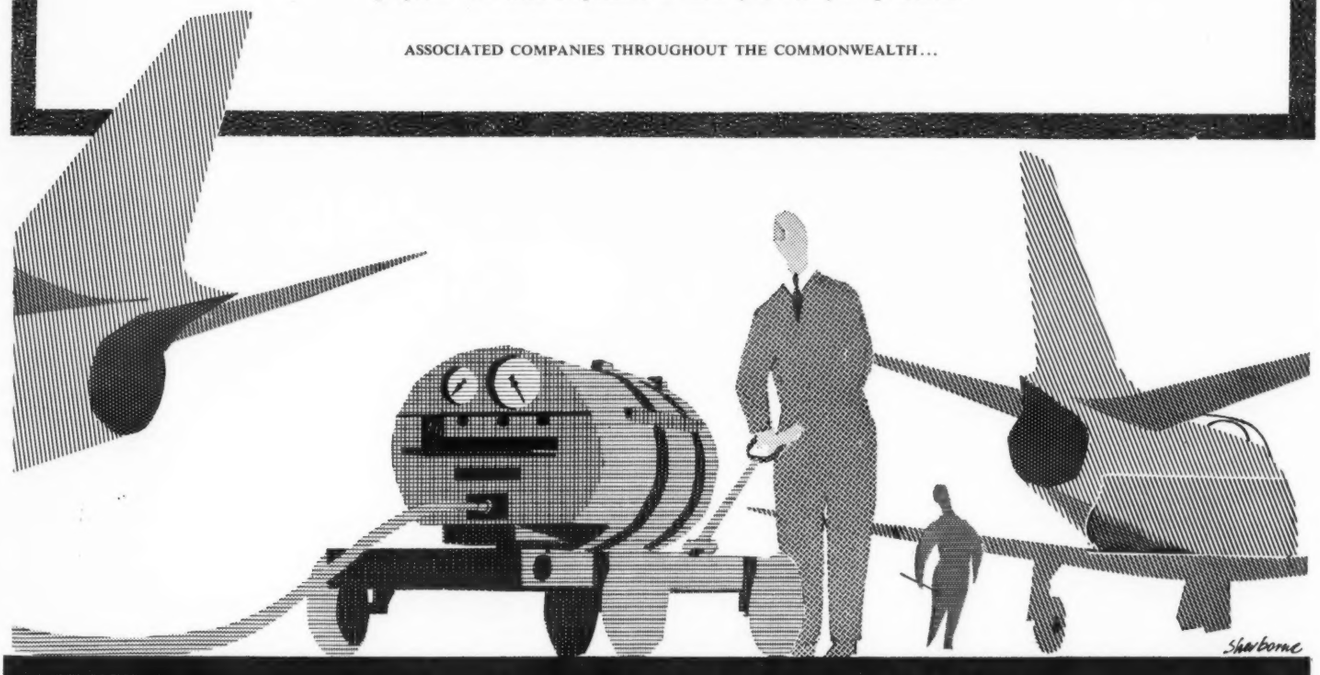

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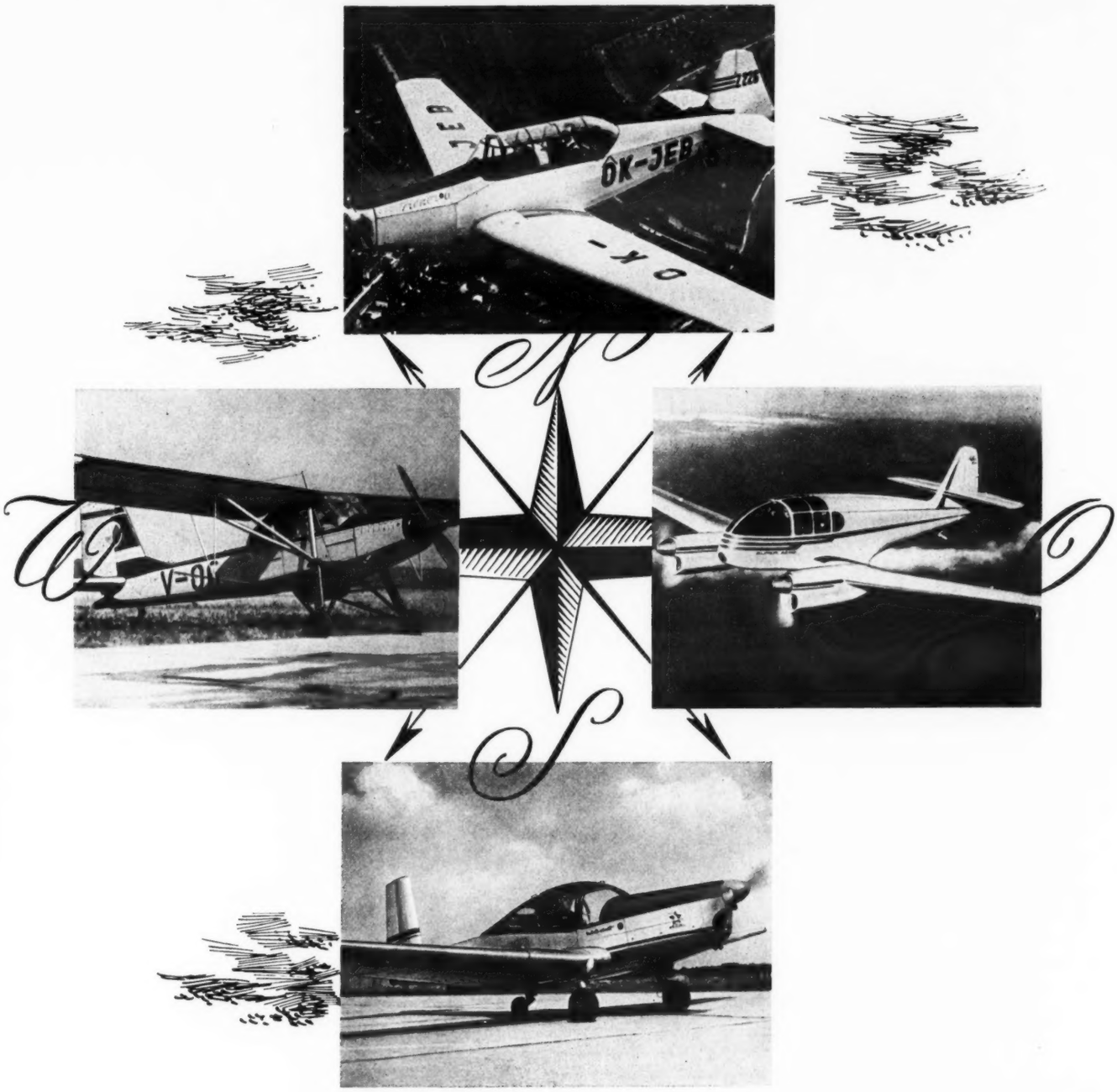

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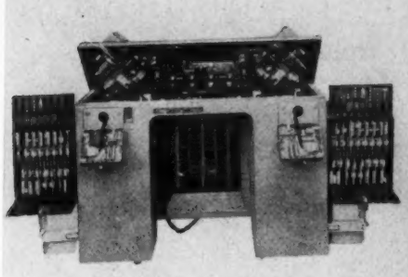

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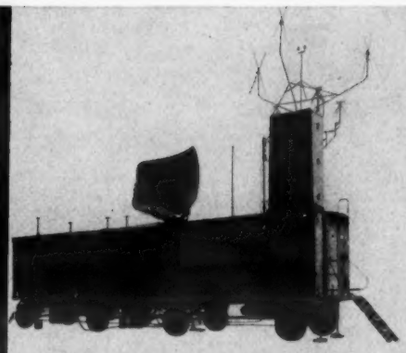
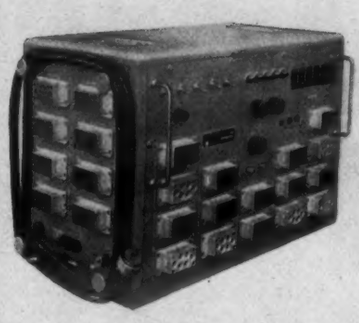
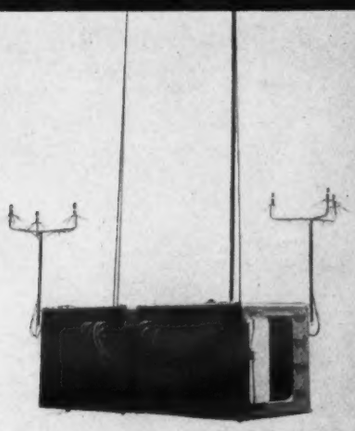


2. GROUND CONTROLLED APPROACH RADAR SYSTEM AN/MPN-11 for air safety, is contained in two ground- and air-transportable vehicles. It provides a completely self-contained navigation aid that operates worldwide.



3. PORTABLE MAINTENANCE JUNCTION BOX allows functional equipment groups of complex radar sets to be interconnected on a maintenance bench. The mobile box provides accurate testing for comprehensive subsystems.



4. COMPLETE TACTICAL AIR TRAFFIC CONTROL CENTER AN/TSQ-18 is reduced in size and weight to three packages for helicopter transport. The system functions in all weather at forward air strips and in terminal areas.

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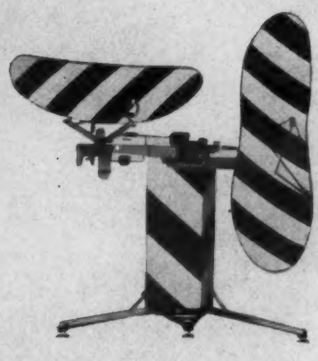
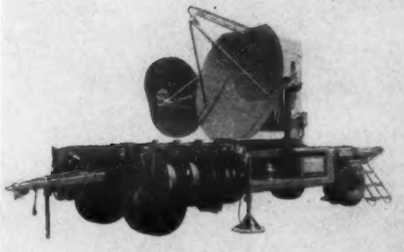
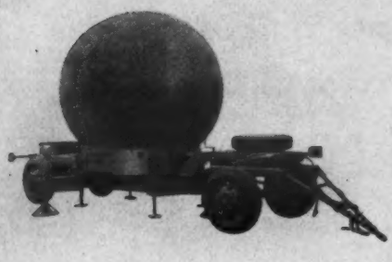


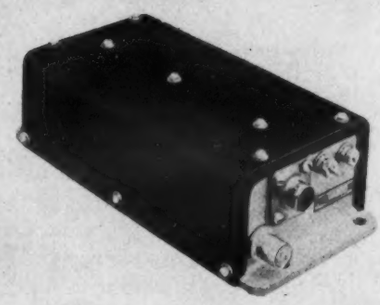
5. LIGHTWEIGHT GCA RADAR SET, QUADRADAR, AN/FPN-33 is a highly mobile surveillance, approach, landing and taxi system that has achieved an enviable world-wide record of operation with both military and civilian users.



6. GROUND-BASED COUNTERMEASURES AN/MLQ-7 is a ground jammer for use against airborne bombing radars. Equipment supplies broad frequency coverage, rapid reaction capability with advantages of semi-automatic operation.



7. RADAR-TRACKER INTERROGATOR OA-1333/MSW-2 with radome (portion of an all-weather system). Developed for Corporal System as a low-priced, high-accuracy and -performance radar, uses can now include range instrumentation.



8. FM-FM TELEMETRY TRANSMITTER 86600 operates in VHF frequency spectrum of 215-235 and 235-260 megacycles. High-reliability, small size transmitters meet all IRIG requirements, including rejection of spurious responses.

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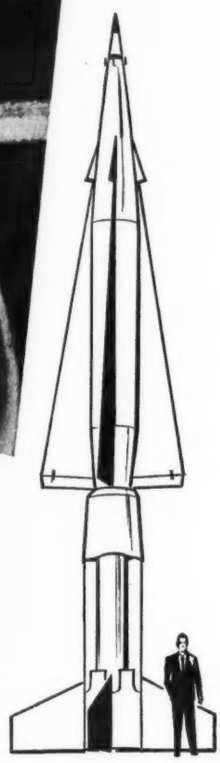

NIKE HERCULES . . .
is the most advanced weapon of the *Nike* missile family now in volume production. In getting *Nike* operational, all procedures of maintenance and training were carefully worked out. Douglas field service men are prepared to help adapt these systems to any defense plan.

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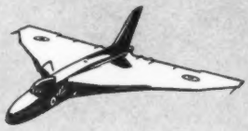

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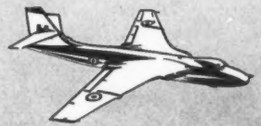

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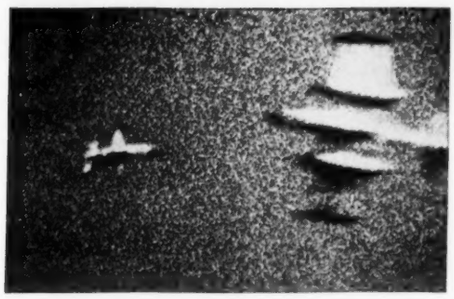
Surface-to-air guided missiles represent the most important advance in defence against air attack since aerial aggression began. These unmanned interceptors are not committed to a pre-determined course, but, even after launching, take corrective action against target aircraft evasion.



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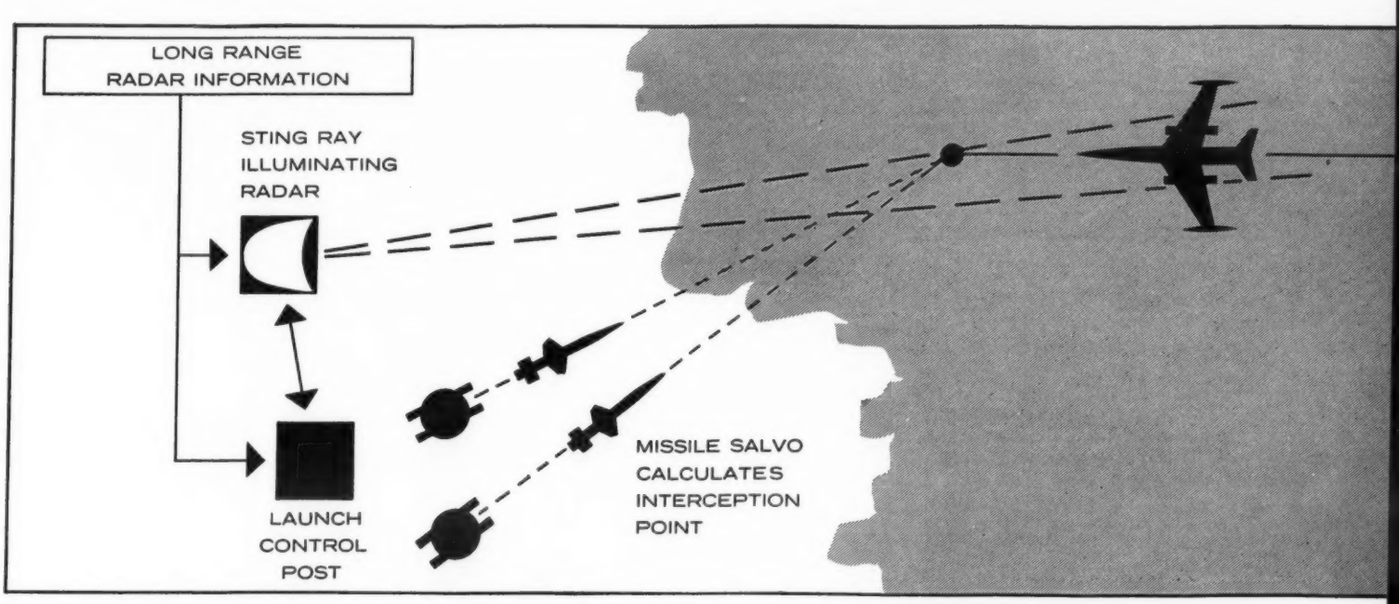
The world's most effective surface-to-air guided missile system is Bloodhound. Already in operational service with the RAF and adopted by non-NATO Sweden. Bloodhound is now to be further developed for the RAF. Bloodhound has been proved in many hundreds of test firings. It exists for defence—*now*.



WHAT BLOODHOUND PROVIDES

By using radar intelligence, enemy aircraft may be allocated for interception either to Bloodhound missiles or to manned fighters.

Essentially a deterrent designed to frustrate not to initiate aggression, Bloodhound contributes to air defence the advantages of very effective high fire power which is always available for action at a moment's notice. And the development of Bloodhound is still in its infancy.

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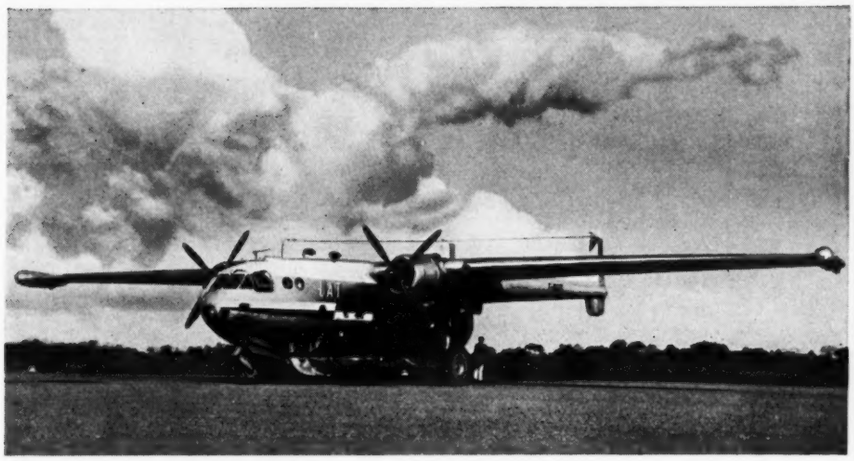

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Other features : Extremely light weight . . . low oil heat rejection . . . self-contained, self-cooling lubricating system . . . high temperature operation . . . constant speed output pad available for additional accessories . . . sizes from 20 KVA to 90 KVA.

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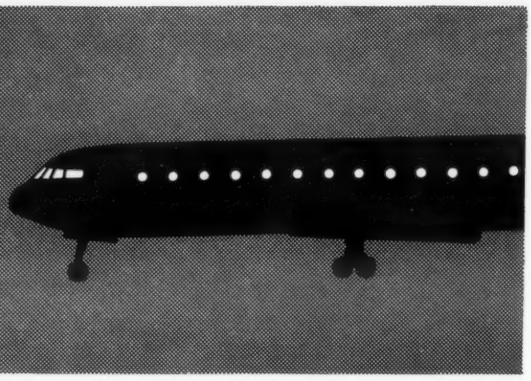
STAN 7-8-9

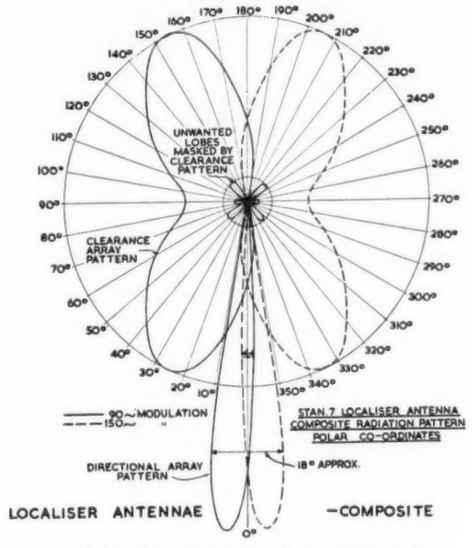


HIGH ACCURACY ILS GROUND EQUIPMENT

The STAN 7-8-9 ILS Ground equipment has been designed to provide an improved performance by use of a dual beam Localiser (STAN 7) in order to reduce substantially the effect of site imperfections.

Newly designed constant input impedance mechanical modulators provide amplitude modulation with no phase modulation.

The equipment is extensively transistorised and one Dual Localiser with one Dual Glide Path equipment contains only 28 valves (14 working).



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STAN 7 LOCALISER EQUIPMENT

STAN 8 GLIDE PATH EQUIPMENT

STAN 9 MARKER EQUIPMENT

The STAN 7-8 is in quantity production for the British Ministry of Transport and Civil Aviation and the STAN 7-8-9 has been ordered by Radio Suisse for Zurich Airport and by the Régie des Voies Aériennes for Brussels Airport.

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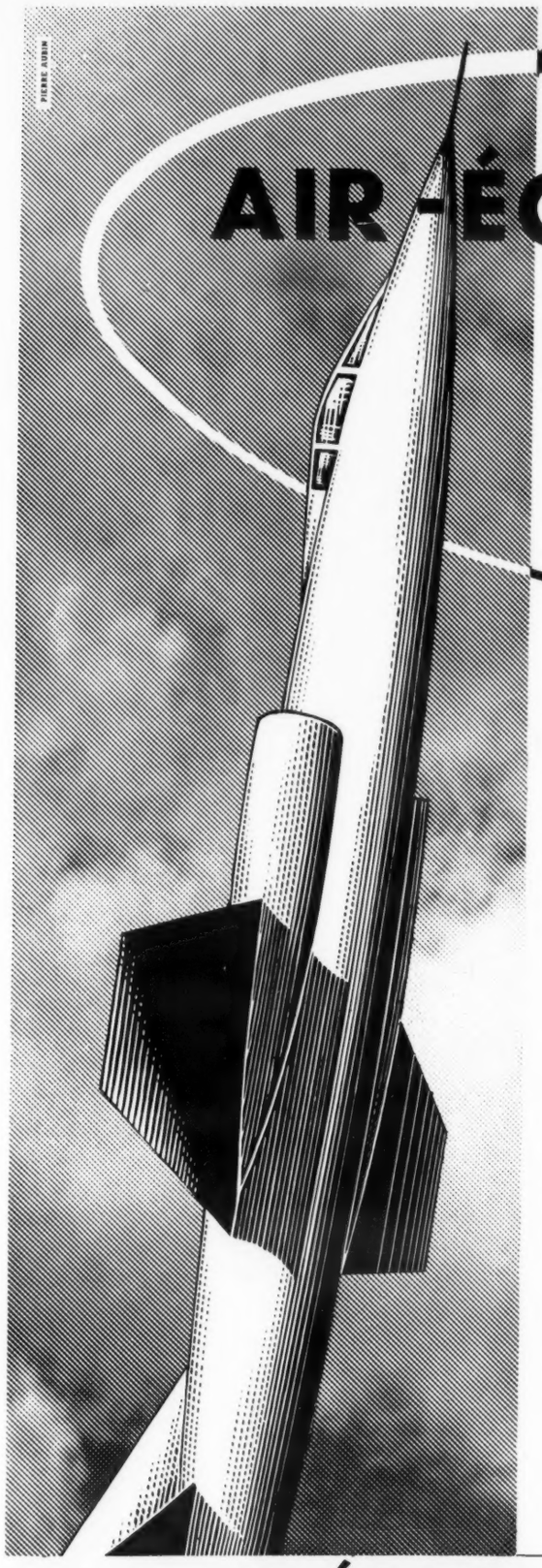

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AIR-ÉQUIPEMENT's long experience in the manufacture of over 6,000 jet engine feed pumps has resulted in the design of high-pressure hydraulic pumps achieving very high performances.

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Among aircraft fitted with these pumps is the SE 210 CARAVELLE.

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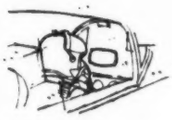
Gyros, accelerometers and computers that send a missile home by "remembering" where it started, where it is, where it wants to go.



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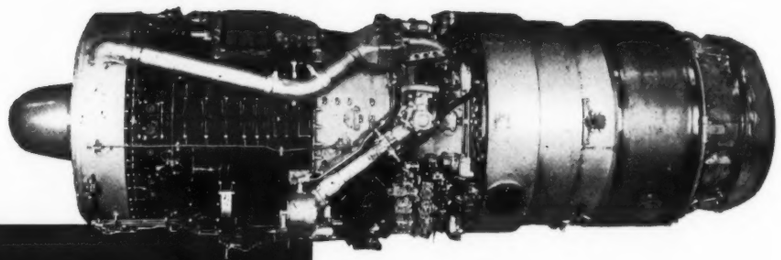
1300 HOURS BETWEEN OVERHAULS FOR ROLLS-ROYCE AVON TURBO JET

On July 3rd 1959 the British Air Registration Board approved an extension of overhaul life of the Avon RA.29 to 1300 hours. The Avon entered commercial service on the North Atlantic route with British Overseas Airways Corporation on October 4th 1958 at an overhaul life of 1000 hours. Approval has also been given for trials at 1600 hours between overhauls.

During overhaul life no scheduled engine unit changes are made apart from the fuel filter element and no internal inspection of the engine is necessary



ROLLS-ROYCE

AVON TURBO JETS

4 MAN-MINUTES PER FLYING HOUR FOR ALL AVON MAINTENANCE

This figure includes the installation of the engine and its removal from the aircraft.

Avon engines are in service with, or on order for:

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ONE UNSCHEDULED OVERHAUL IN 49,000 ENGINE HOURS

During the first nine months of Comet operation by B.O.A.C. only four engines were removed in 49,000 hours flying for causes considered to be Rolls-Royce responsibility. Only one of these required overhaul, the other three being rectified and returned to service.

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General Keirn Urges Flight Testing of Atomic Powerplant

What Major General Donald J. Keirn had to say to the U.S. Congress Joint Committee on Atomic Energy reads almost like an essay on " Guided missiles and manned aircraft ".

The General's statement on the Aircraft Nuclear Propulsion Program (ANP) was in a sense his military testament ; on August 31st, 1959, a few weeks after the hearings, he resigned as Director of the Defense Department's nuclear-powered aircraft project and retired from the Air Force, in which he had served for 30 years.

To say that the General had openly complained of dilatoriness in the nuclear-powered aircraft project would be unjustified. His remarks were down-to-earth and uncontroversial, and he abstained from all overt criticism. And yet it was quite plain that behind General Keirn's words was the unexpressed exhortation : Get on with the job !

The General began his statement by vigorously demanding that the security regulations for the ANP Program should be relaxed.

" This is the first open hearing that has been held on the Aircraft Nuclear Propulsion Program. We welcome the opportunity to present additional information on the program to the public... The technology gained in the ANP Program will benefit this country's technological position in many areas. For this reason there is a strong urge to declassify the ANP Program...

"... We have recently reviewed our classification guide under ground rules which should enable us to declassify some segments of the program. This I hope will serve two purposes. First, it will permit a more general application of some of the technology developed in aircraft nuclear propulsion towards some of our other reactor programs ; and, second, it will permit certain simplifications in management procedures, and thus permit economies within the ANP Program itself..."

Put more plainly, this can only mean that, in the speaker's opinion, present management procedures are not altogether ideal.

But this desire for less secrecy is not the only sign of Major General Keirn's wish to " get things moving ". From his review of the stages of the nuclear-powered aircraft project so far complete, it is easy to see that the rate at which it is progressing is not entirely to his liking.

Basically, the projects whose realization is now under discussion are five to eight years old. The Convair Division of General Dynamics Corporation put forward an airframe design for a nuclear-powered aircraft as early as 1954 ; General Electric Company's plans for a nuclear powerplant, submitted in September, 1951, have not been fundamentally altered ; and a reactor design by Pratt & Whitney dates back to roughly the same period.

These were the designs discussed by the selection committee for the *CAMAL (Continuously Airborne Missile Launching and Low Level Penetration) Weapons System*. In its final report the committee recommended the old Convair 1954 project. And although a definite decision has still to be taken, it is highly probable, according to General Keirn, that the final prototype will incorporate many features of the Convair model.

★

Why are General Keirn and the U.S. Air Force in such a hurry ? Among the reasons is the need for an efficient strike force, whose full mobility depends largely on the long-awaited appearance of the new powerplant. This brings us to the role of the nuclear-powered aircraft within the USAF concept, to which General Keirn refers in his statement.

- " The first point I wish to make, " says General Keirn," is that a basic requirement in the accomplishment of the Air Force's primary strategic deterrent mission has been the development of the capability to deliver devastating striking power to the heartland of any enemy wherever that nation may be geographically... The range limitations of chemically fueled aircraft have forced us into dependence upon aerial refueling and staging techniques, the latter requiring the procurement and support of air bases on foreign land. Nuclear powered aircraft will eliminate these operational complexities and lessen our reliance on the availability of foreign bases. The advantages of the additional operational flexibility, greater mobility, reduced operational complexity, and extended range and endurance available to the combat commander cannot, in my opinion, be overstressed...

- " Another point I wish to make has to do with other mission applications. We have evaluated Air Force requirements in other mission areas such as logistic transport and airborne early warning. We have not yet been able to find an economic basis for establishing operational requirements for nuclear powered aircraft to accomplish these missions. The cost involved in this program has appeared warranted only by the priority of the Air Force's primary strategic deterrent responsibilities. The program has not, therefore, been initially oriented toward powerplants characteristic of the other mission requirements. One should keep in mind, however, that the technology currently being developed for strategic systems will be directly applicable to other objectives when detailed requirements for such objectives are established."

Major General Keirn then dealt in some detail with the differences of opinion on the installation of powerplant and reactor which had led to delays in constructing the prototype, and came to the following conclusion :

" ... It is my personal conviction that we have reached a point where it is now appropriate to commence the design and construction of an experimental aircraft suitable for flight testing the propulsion systems presently under development and of evaluating the operational characteristics of such an aircraft as a first step in determining the manner in which the unique capabilities of nuclear power in the air can best be utilized. Commencing such flight testing with a propulsion system, even though it does not meet the military performance as specified in the General Operational Requirement No. 172, still... permits us to tackle the many problems of flight, maintenance, servicing, and problems associated with operational techniques irrespective of whether or not the aircraft would be flown at maximum performance. I believe that these problems can be solved concomitantly with the development of improved reactor cores and that these improved cores can subsequently be installed to provide full performance of the aircraft. Waiting for the full performance cores before initiating such a flight test programm needlessly delays the program, and in the long run is a more costly procedure."

★

Thus far Major General Keirn. To what extent his warning is justified is attested by a report of USAF contract cancellations received from Washington in mid-August. The programme for the development of high-energy boron fuels and the J93-5 jet powerplant is to be cancelled, and it is probable that the USAF will slow down development of the North American B-70 *Valkyrie* bomber. The latter decision is considered in Washington as yet another sign that the days of the manned bomber are numbered.

If Major General Keirn and the USAF have their way, however, then the last word has not been spoken on the B-70 and other manned bombers, nor on escort fighters and long-range reconnaissance aircraft. All these will still have an opportunity to prove that they, with their human crews, are superior in many fields to the robot with its " standardized " and hence primitive brain.

And the U.S. Navy ?

Since the ANP Program was drawn up, the U.S. Navy has been participating on a limited scale in the USAF program, and in 1955 sent personnel to work in the Atomic Energy Commission's Aircraft Reactors Branch, directed by Major General Keirn. The Navy's primary interest was in the development of a nuclear-powered turboprop aircraft.

At the beginning of August, 1959, however, the Navy decided to start work on a project of its own. The Martin Company of Baltimore was awarded a contract for studies on an airframe for a nuclear-powered turboprop seaplane. Admiral J.T. Hayward, Assistant Chief of Naval Operations for Research and Development, said in a statement to Congress that it is planned to have the prototype complete by 1964.

Admiral Hayward's report indicated that the Navy is seeking an aircraft for logistic purposes, anti-submarine and early warning tasks, in which speed will be a secondary consideration to range and endurance.

Which prototype will be the first to fly, the USAF's nuclear-powered Convair (Weapon System 125A) or the U.S. Navy's Martin seaplane ?

INTERNATIONAL MEETINGS AND CONFERENCES

September 7th-13th : SBAC Display and Exhibition. Farnborough, England.

September 9th-14th : AGARD Meeting : Wind Tunnel Panel (The Use of Wind Tunnels in Aircraft Development Testing). Modane and Marseilles, France.

September 10th : Canadian International Air Show at the Canadian National Exhibition. Toronto.

September 10th-13th : Eighth Rocket and Astronautics Conference of the German Rocket Society. Cuxhaven, Germany.

September 21th : IATA Traffic Advisory Committee. Honolulu, Hawaii.

September 13th-19th : Golden Anniversary of Flight Week and International Air Show. Windsor, Ont., Canada.

September 14th : IATA Composite and Joint Meeting of Traffic Conferences. Honolulu, Hawaii.

September 14th-19th : First International Conference on Agricultural Aviation. Cranfield, Bedfordshire, England.

September 14th-23rd : AGARD Meeting : Materials and Structures Panel. Aachen, Germany.

September 16th-17th : IAS Western Regional Meeting on Frontiers of Science and Engineering. Los Angeles, Calif., USA.

September 20th : National Glider Aerobatic Contest organized by the British Gliding Association and London Gliding Club. Dunstable, England.

September 21st-23rd : AGARD Meeting : Flight Test Techniques and Instrumentation Panel (Air Space and Associated Problems Encountered in Supersonic Testing). Aachen, Germany.

September 21st-23rd : AGARD Meeting : Avionics Panel (Automatic Data Handling). Aachen, Germany.

September 21st-23rd : AGARD Meeting : Aero-Medical Panel (Acceleration of Bio-Assay Techniques for Human Centrifuges). Aachen, Germany.

September 21st-23rd : AGARD Meeting : Wind Tunnel Panel (High Temperature Gas Characteristics). Aachen, Germany.

September 22nd : IATA Fall Traffic Conference. Honolulu, Hawaii.

September 24th-25th : American Rocket Society Solid Propellants Conference. Princeton, N.J., USA.

September 28th-29th : Fourth Leonardo da Vinci Aeronautical Conference. Paris.

September 28th-30th : 1959 National Symposium on Telemetering. San Francisco, Calif. Sponsor : Institute of Radio Engineers' Professional Group on Space Electronics and Telemetry.

September 30th-October 2nd : Ausschuss für Funkortung Conference on Radio Navigation in Aviation and Shipping. Essen, Germany.

October 4th : Joint Meeting of the Canadian Aeronautical Institute and the International Aviation Society. Toronto.

October 5th-10th : Society of Automotive Engineers, National Aeronautics Meeting, Aircraft Manufacturing Forum and Aircraft Engineering Display. Los Angeles, Calif.

October 5th-16th : Seventh Anglo-American Aeronautical Conference. New York.

October 6th-8th : National Airports Conference, sponsored by the American Association of Airport Executives and the University of Oklahoma. Norman, Okla., USA.

October 6th-9th : International Symposium on High Temperature Technology, sponsored by Standford Research Institute. Asilomar, Calif., USA.

New York Finance Notes

Jet Operations in Dollars and Cents

Profits for Airlines, Losses for Manufacturers

BY SCOTT HERSHEY, NEW YORK

A picture is beginning to develop reflecting the jet transports so enthusiastically received by the travelling public.

Air travellers are not particularly concerned with the picture, but the manufacturers of jets, the operators of jets and the investors in aviation securities all are tremendously interested and are watching the development closely.

Despite the complexities of the advent of the jet age, the financial situation at this time is basically simple : The people who are operating the jets are making money. The people who are making the jets are not making money—at least not yet. There are a number of examples, but one or two will suffice, since they are typical, to give aviation security holders the trend as mid-year figures become available.

Trans World Airlines, which has had its financial troubles in the past, had a net income for the June quarter which was the best of any quarter in the company's history. It reached $5,342,000 or 80 cents a share, against a net loss of $203,000 for the same period a year ago. Charles S. Thomas, TWA President, credits most of the improvement to the introduction of the Boeing 707 jet transports, on which the load factor since March has been 94 percent.

For the six months to June 30th, net income was $1,546,000 or 23 cents a share against a net loss of $10,604,000 a year ago. TWA shareholders are thus able to see a slight break in the cloudy financial skies.

Jet travel is paying off very well for American Airlines, too. The line in June had the biggest traffic month in aviation history. It should be noted that American has an advantage in that it has the largest turbine fleet in operation—16 Boeing 707's and 16 Lockheed *Electras*—serving a dozen large U.S. cities. American has about 160 piston engine aircraft in service.

The enthusiastic public response to jet air travel has kept the 707 load factor at around 95 percent, the *Electras'* at about 85 percent. The effect of the passenger-filled jets on the overall load factor for June, including piston-engine planes, was to jump it to 80 percent from 71 percent in May and 70 percent in June a year ago, when American had no jet planes.

The effect of the jet operation is obvious, and investors looking to the future might keep in mind that American, sometime in 1962, will be virtually 100 percent equipped with the new craft. The line has ordered more jets than any other in the world, and through astute financing, both in the sale of present equipment and the acquisition of new, should be in a good competitive position in a highly competitive industry.

It is almost axiomatic that as load factors rise, profit margins rise along with them. Some leverage also appears in the company's capital structure, which includes $205 million in promissory notes and debentures and 93,389 shares of 3 1/2 percent convertible preferred stock.

American flew back into black figures for the June quarter following a substantial loss in the first quarter of this year, occasioned mainly by a pilot's strike. Net income for the quarter was a hefty $9,105,000 or $1.18 per share. In the same quarter last year, the net was $5,567,000 or 69 cents a share.

In addition, the June quarter net more than offset the first quarter's loss, producing for six months to June, net income of $8,827,000 or $1,07 per share, against $7,202,000 or 88 cents a share in a like period the year before.

The common shares of American have experienced some fairly wide price swings in the past and probably should not be considered by the conservative, unsophisticated investor. But for the astute investor who can afford some degree of risk and can have patience to gain corresponding profits, American shares, recently at 28 5/8, look attractive.

On the other hand, consider the story at Douglas—the Boeing story has already been told, but the pattern is the same. Costs higher than expected on the DC-8 jet transport program and a renegotiation refund of $2,867,000 combined to produce for Douglas a first half loss of $15,010,000. In the same period a year ago, Douglas had net income of $12,644,812 or $3.31 per share.

The DC-8 program research and development costs in the latest period were $17,730,000, a decrease from the $27,839,000 a year ago, but the heavier production costs resulted in inventory write-downs of $21,240,000 against $6,934,000. Additional charge-offs on this program are expected to result in further losses in 1959, according to the management report.

But no one would sell Douglas short, and later deliveries of the aircraft, the management reports, are expected to be profitable.

Consider also the case of Lockheed Aircraft Corp. Lockheed averaged $100,000,000 sales a month during the first half of 1959. This brought the volume to $607,903,000, largest in the company's history and 31 percent ahead of last year's $465,735,000 total for the first half.

The result of this spectacular performance : Net earnings were $8,840,000 or nine percent less than the $9,743,000 reported the year before. The earnings were equal to $1.37 a share on the average of 6,430,000 shares outstanding during the period, compared with $1.65 on the 5,911,000 average number of shares outstanding last year.

The management said the lower net reflects primarily the fact that the sales of the *Electra* jet prop are being recorded at a loss while a year ago *Constellation* sales were profitable. The management report added that this probably had been the pattern with most post-war transports, showing a loss the first year or two.

Lockheed said sales prospects for the *Electra* have brightened, and the company expects the plane to have a commercial and military life equalling the ten-year success of the *Constellations*. The past history of Lockheed, like that of Douglas, is too solidly a part of the air transports to give anybody the temerity to say nay.

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- BUT WHAT ABOUT...

TRAINING FEATURES?
Instruments and navigation aids to the latest operational standards. High performance—but docile handling qualities throughout its height and speed range.

SPEED?
The Folland Gnat Trainer has been specifically developed to demonstrate transonic behaviour to pupils in ease and safety, up to M = 1.15.

CLIMB?
40,000 ft in 7 minutes from start, ceiling over 50,000 ft.

ENDURANCE & RANGE?
A full hour's training programme on internal fuel, maximum endurance nearly 3 hours, or Radius of Action over 500 nautical miles.

MANUFACTURE?
From conventional materials with simple jigs and tools. The Gnat Trainer, like the Mk. 1, is very suitable for production under licence.

DEVELOPMENT?
The Trainer version of the Gnat Mk. 2 with a reheated engine will reach Mach 1.5 in level flight and climb to *50,000 FT. IN 3 MINUTES.*

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Operational version ordered by the Indian, Finnish and Yugoslav Air Forces

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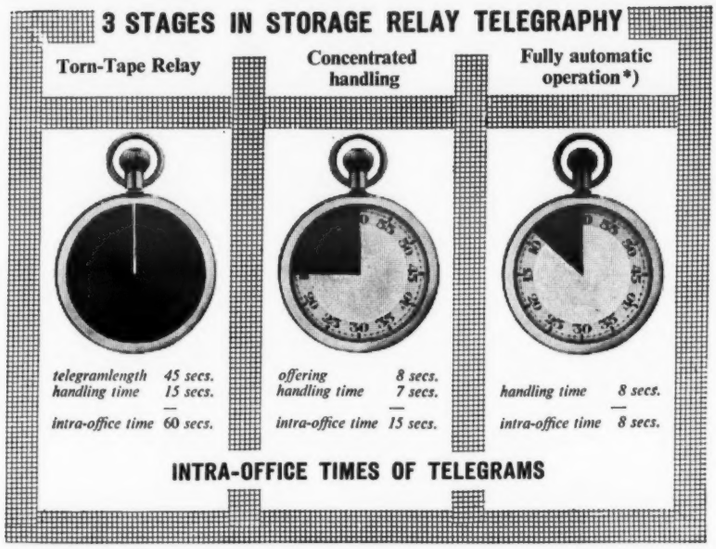

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J 79: world's most-flown Mach 2 engine

General Electric's J79 turbojet has demonstrated its reliability by logging more flight hours than any other Mach 2 engine in the world. Typical of the J79's record is its outstanding performance in the Lockheed F-104 Starfighter—world record holder for speed, altitude, and time-to-climb.

Operational flying with the USAF's Air Defense Command and Tactical Air Command demands the most of an aircraft and its engine. In the face of these requirements, the F-104 is compiling an outstanding record.

Evidence of its J79 engine's reliability grows more overwhelming daily. During 1959, USAF Starfighters have been realizing an unusually high aircraft utilization rate, with a correspondingly low percentage of in-flight engine complaints.

Some key reasons for the J79's outstanding operational record are the simplicity of its single rotor variable stator design, high resistance to foreign object damage, unusual throttle sensitivity, high altitude afterburner light-off characteristics, and ease of maintenance.

More than 90% of total U.S. Mach 2 flight time has been logged by General Electric J79s . . . further evidence that it is today's top Mach 2 fighter-interceptor powerplant. General Electric Co., Cincinnati 15, Ohio.

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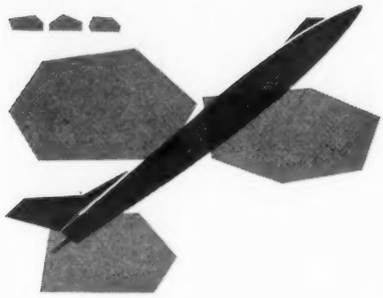


Dramatic Weight-Reduction in Airborne Search Radar!

EKCO LIGHTWEIGHT SEARCH RADAR

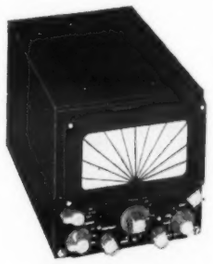
Ekco, first in the world with commercial Airborne Search Radar, now announce yet another major Ekco advance in this field—EKCO Lightweight Search Radar.

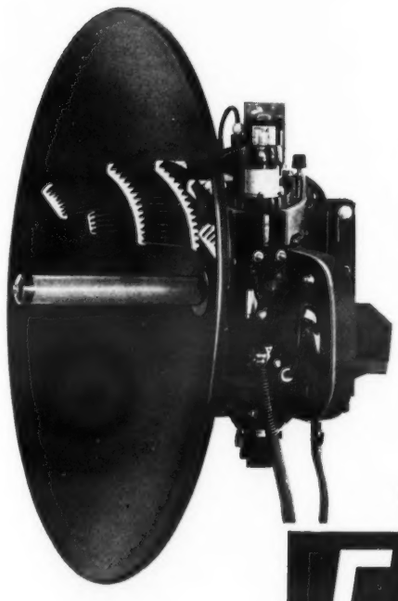
This new equipment reduces the total weight to only 56 lbs—less than half that of previous systems! Yet, Ekco Lightweight Search Radar provides all the facilities of a modern Weather Radar System, including a fully-stabilised 24″ antenna, 150 mile range and high brightness display.

The reduction in size and number of units, made possible by the extensive use of transistors, allows a consequent saving in installation costs and mounting weight.

These three compact units make up the new Ekco Lightweight Search Radar:—
1. Indicator
2. Scanner
3. Transmitter Receiver

1





2

3

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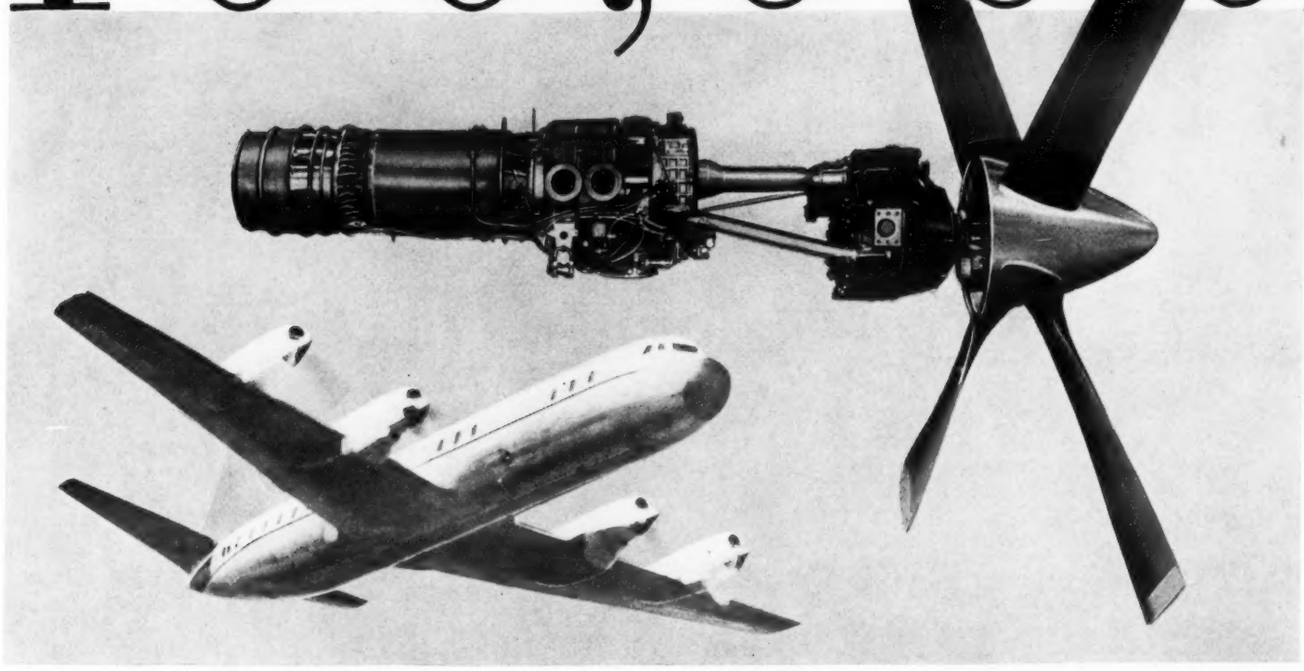
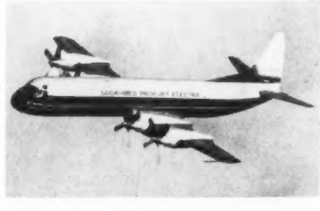


Flight Hours Per Month

Allison prop-jet power daily is proving its flight durability and dependability in airline service around the world. Flight experience is being accumulated in both military and commercial service at the rate of 100,000 hours a month with the rate increasing rapidly as new aircraft go into service.

Consisting of the matched team of Allison model 501 prop-jet engines and Aeroproducts 606 turbo-propellers, Allison prop-jet power is setting new standards of economical operations. Operators find its high power and good takeoff thrust enable higher payloads and reduced trip time. With constant engine propeller speed in flight, ample power for any requirement is available **instantly.** For **modern** prop-jet power, look to Allison prop-jet power.

Allison-powered C-130 military freighters have logged more than 750,000 hours.

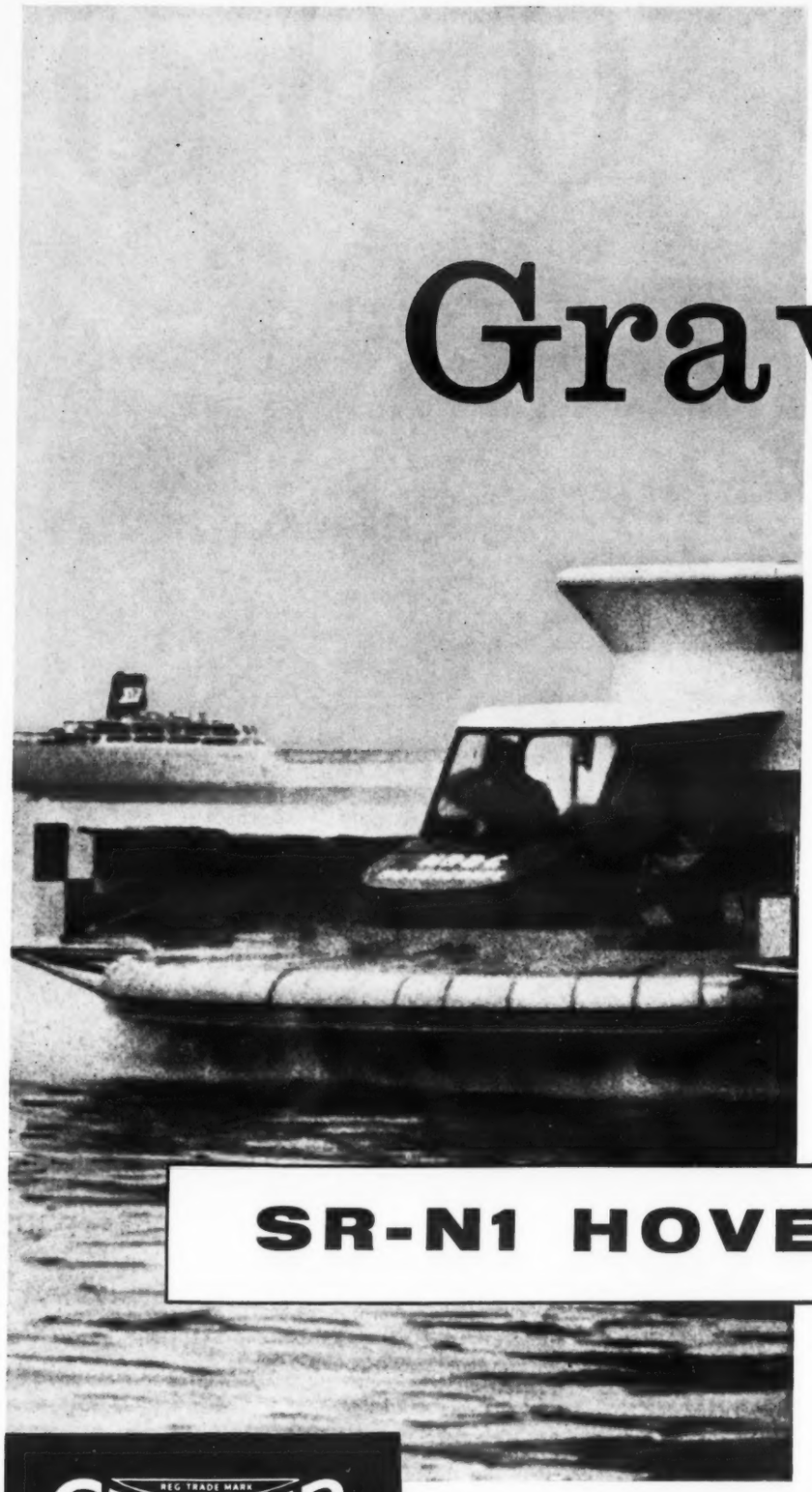


Allison-powered Lockheed Electras are now in service with 10 of the world's leading airlines.

The Allison model 501-D13 engine is a logical choice for conversion of piston-powered aircraft to turbine power.

ALLISON PROP-JET POWER

GM
JET POWER



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fire protection equipment

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SR-N1 HOVERCRAFT

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... first in airborne fire protection equipment

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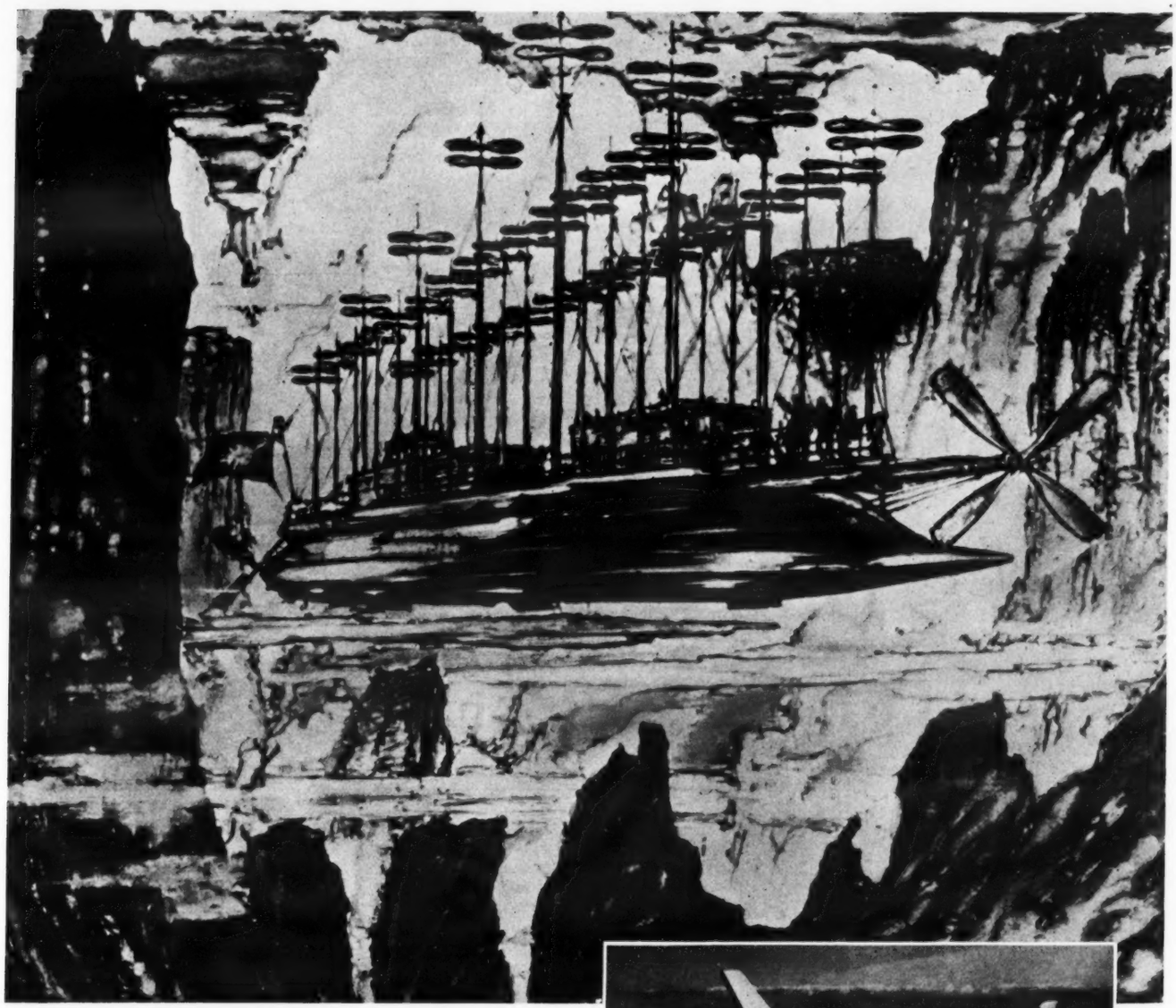
G67

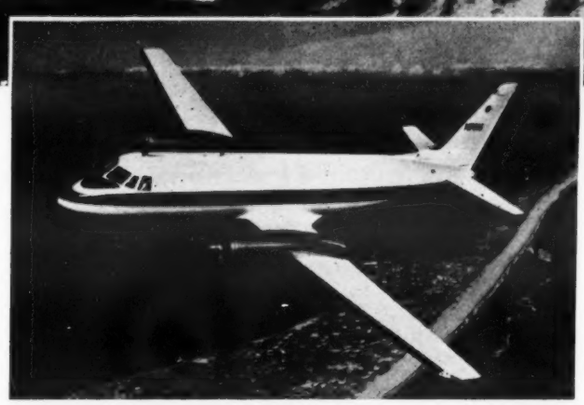
Propulsion through the ages...



Great imagination—
Jules Verne's aerial ship of 1886.

This is the Albatross, product of the vivid and prophetic imagination of Jules Verne, the famous Victorian " science-fiction " writer. In his book " Clipper of the Clouds " we read of the vertical take-off and landing of the Albatross, effected by a series of contra-rotating propellers; the transition to forward flight by the engagement of four-bladed tractor and pusher propellers; the 125 m.p.h. top speed, and the ceiling of 8,700 feet. With a crew of eight, the varied equipment of the Albatross included cooking stoves, and a printing press !

Jules Verne dreamed, and wrote; he created airmindedness in his readers. Rotol dreamed, and built; they produced the propellers for the first turbo-prop aircraft to fly in this airminded age.



GRUMMAN GULFSTREAM *Two Rotol four-bladed propellers powered by Rolls-Royce Dart engines give Britain a major share in the success of this U.S. designed and built aircraft. The Gulfstream is in fact the first such aircraft to " buy British " in this way.*

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A member of the Dowty Group

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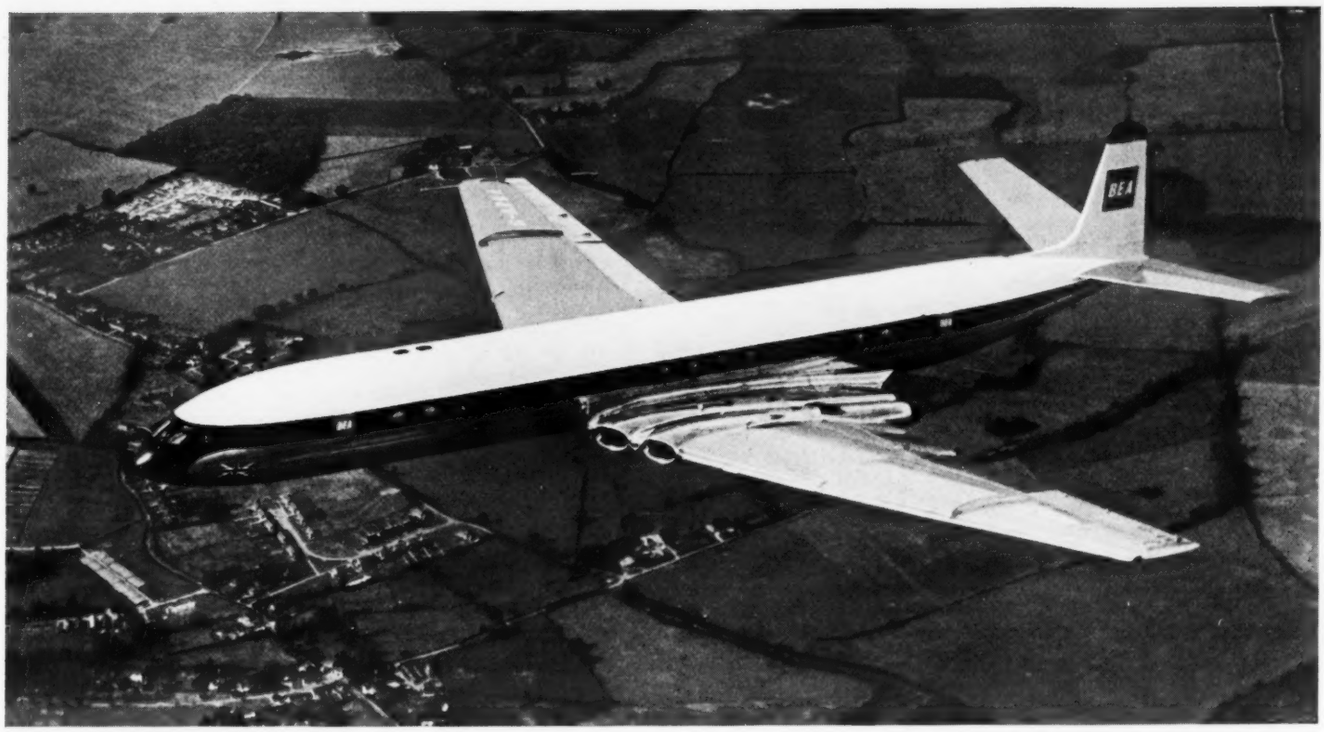

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S.B.A.C.
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reversible airline liferaft with inflatable canopy

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Beaufort's latest liferaft development provides a reversible multi-seater liferaft with an instantly inflatable self-positioning and permanently attached canopy

demonstrations arranged anywhere

★ IMMEDIATE BOARDING.
No restrictions of boarding positions since survivors can jump straight into the liferaft—and if they do have to enter from the water there is an inflated boarding ramp.

★ HIGH TENSILE FABRICS AND SYNTHETIC POLYMERS.
No problem on stowage deterioration since the new high tensile lightweight synthetic fabrics and polymers have been specially developed for this liferaft.

★ FULL CANOPY PROTECTION.
No heat exhaustion in the tropics and no exposure problem in the arctic, since the inflatable canopy design allows a wide range of adjustment by the survivors.

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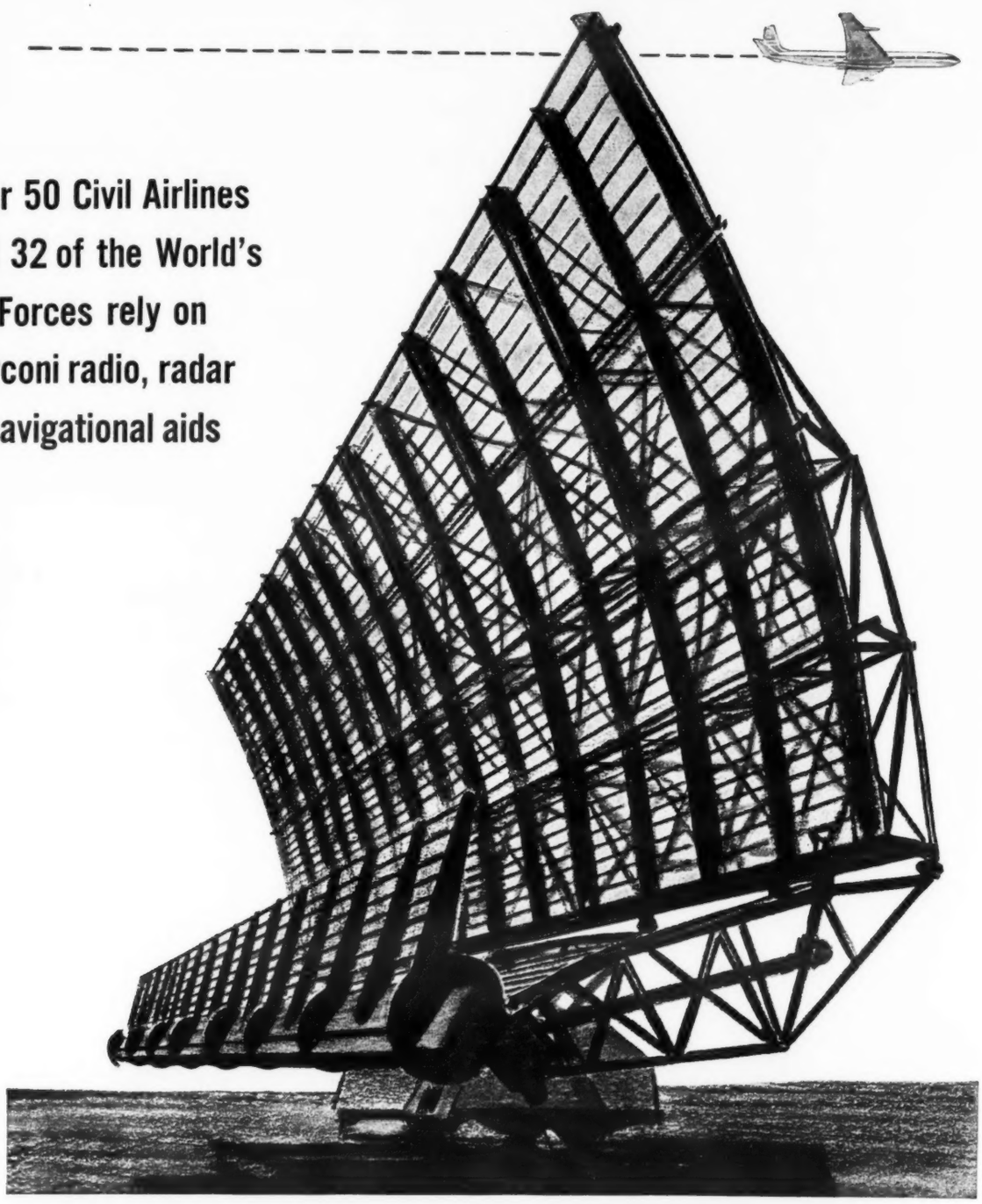
2539

Marconi in Electronics for Aviation



Over 50 Civil Airlines and 32 of the World's Air Forces rely on Marconi radio, radar or navigational aids

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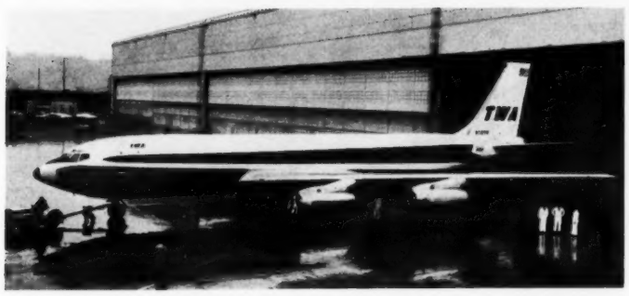
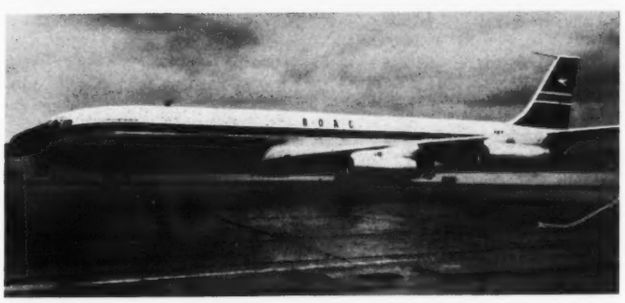




Seventy-two 707s rolled out for eight airlines

Seventy-two Boeing 707 jetliners, bearing the colors of eight famous airlines have rolled out of Boeing's Renton, Washington, plant. Nearly 57 have been delivered. In all, 197 Boeing 707s and 720s have been ordered by 16 airlines and by MATS.

Already, 707s are in scheduled service by Pan American, American, T.W.A., Continental and Qantas airlines. Soon B.O.A.C. will begin 707 operations. Before the end of this year deliveries will be made to Braniff, Air France and Sabena.

707s are also in production for Air India, Cubana, Lufthansa, South African Airways and Varig. In addition, 720s are on order for American, United and Irish airlines.

Since going into service last October, the 707 has attracted the highest loadfactors of any airliner in aviation history. These range from 90 to 95% and indicate the unparalleled profit potential of Boeing jetliners.

Currently, 707s are carrying more than 7800 passengers a day. Already more than half a million air travelers have flown aboard the 707.

Boeing jetliners now in scheduled service are demonstrating tremendous earning power, extremely high initial utilization and unprecedented public acceptance.

BOEING 707 and 720

CHAMPION SPARK PLUG

A foul-resistant new full power at takeoff,

You check magnetos—and the RPM's are " right up there " with new Champion Foul-Resistant Spark Plugs ! You give it the throttle... and you're off *right on schedule* ! Fewer bothersome delays from prolonged burn-out procedure or unscheduled plug removals—despite long flight-time on those plugs ! In the air, your engine purrs smoothly all the way—even on extended cross-country hops where fouling deposits could build up on other plugs. Try these new Champions—see for yourself !

COMPANY ANNOUNCES . . .

spark plug–for smooth climb-out and cruise!

New firing-end design provides greater "self-cleaning" action — a major advance in spark plug engineering!

Champion's foul-resistant new spark plug has been fully approved by leading manufacturers of light aircraft engines in the U.S., and by the Federal Aviation Agency. It has also been thoroughly field-tested by aircraft operators, who report far less plug fouling than with other plug types.

This is because of Champion's completely new firing-end design. A two-pronged electrode plus a larger bore allows greater entry of turbulent combustion gases. These gases clean away many of the deposits that ordinarily form on the core nose. And the core nose is longer, to give even greater exposure to the cleansing gases. This means:

— Greatly improved fouling protection regardless of severity of operating conditions—from idle through takeoff to prolonged flight. (One operator, who normally got only 20 hours on plugs between cleanings, reported 100 hours with these new *foul-resistant* Champions.)

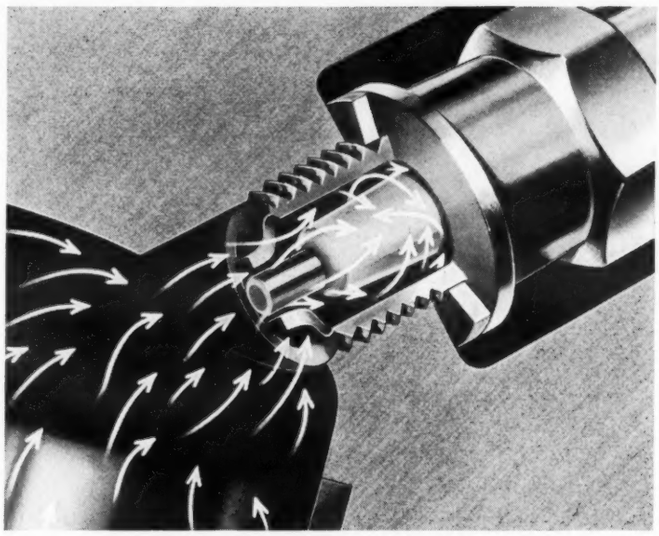
— Fewer unscheduled spark plug removals: More assurance that when your schedule says "go"—you *go!* And you're there on time. (Little danger of being grounded elsewhere to clean or switch plugs.)

— Virtually eliminates burn-out... you'll notice much less RPM drop when pulling your magneto check!

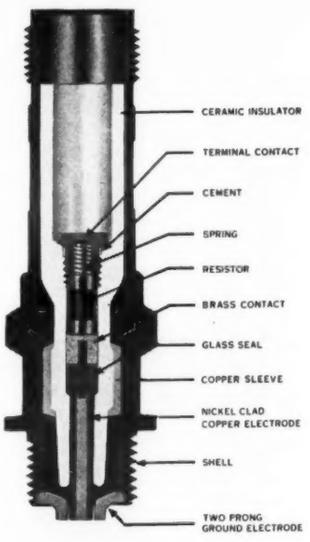
— Engines *remain* smooth—even on prolonged flights where fouling deposits could build up on other spark plugs.

For *peak* performance from *your* engine—smooth, continuous full-firing power and dependability at takeoff or in flight—try Champion's new *foul-resistant* spark plugs!

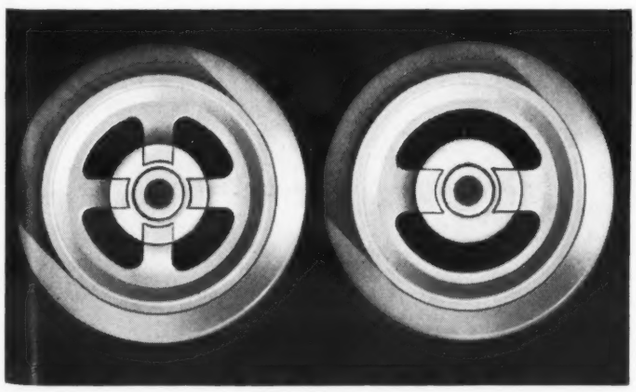
These new plugs incorporate Champion's All-Weather design features, and are available for use with both $^{3}/_{4}$ 20 and $^{5}/_{8}$ 24 ignition harness. Consult your regular Champion source for the correct type for your light aircraft engines.



Longer core nose is exposed to full blast of turbulent, cleansing combustion gases, providing greater protection from fouling-deposit build-up regardless of operating conditions. (Longer core nose also provides longer path to ground to reduce chances of shorting.)



Notice how Champion's new two-pronged electrode design (right, below) provides a larger bore opening, allowing entry of a far greater volume of turbulent, cleansing combustion gases.



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SPARK PLUGS

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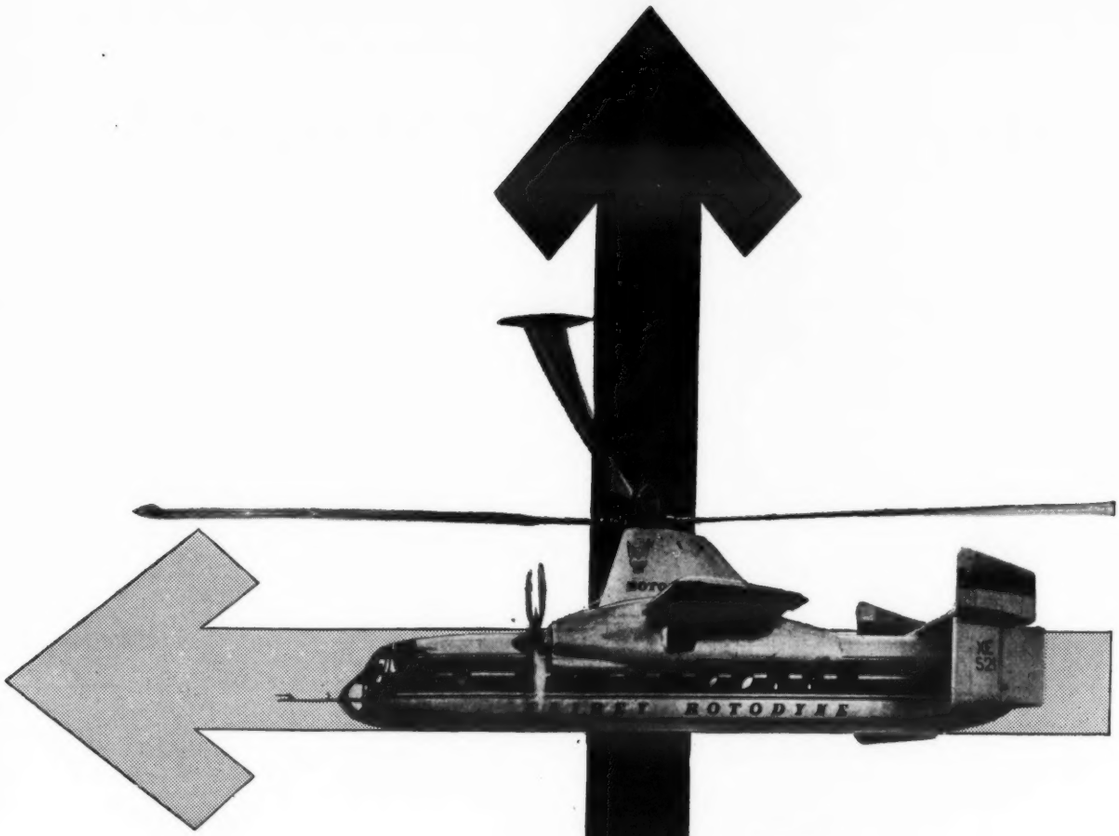

The first vertical take-off airliner

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'Jeep' vehicles are doing the world's work!

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- compact 'Jeep' vehicle units save space and manpower.
- mobile power from *three* power take-off points saves use of other equipment.
- 4-wheel drive 'Jeep' vehicles go *anywhere*. . . anytime . . . in any *weather!*

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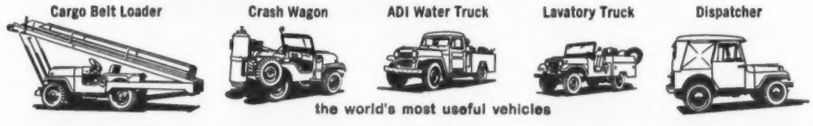
the 'Jeep' family—a balanced line of 4-wheel drive vehicles



the world's most useful vehicles

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AS A FULLY-INTEGRATED WEAPON . . .

Everything connected with the flying and the operating of the ENGLISH ELECTRIC Lightning was designed and developed as a co-ordinated system. The airframe, the engines, the radar equipment, the electronic aids, the armament, the fire control devices—all were planned from the start to make the Lightning safe for its pilot, and deadly for its target.

. . . THE LIGHTNING IS INCOMPARABLE

'ENGLISH ELECTRIC' aircraft

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Introducing Farnborough 1959

The Rt. Hon.
AUBREY JONES, M.P.
Minister of Supply

It gives me great pleasure once more to welcome this Farnborough Display edition of *Interavia* with its attractively presented review of the British aircraft industry's achievements to date.

In the year since the last Farnborough Display there has been a growing realization among the Western Allies of the need for interdependence, a philosophy to which this country wholeheartedly subscribes. Indeed the cost and complexity of modern military aircraft and missile projects are such that it is sensible to attempt them in cooperation.

For the same reason it has become desirable for the aircraft industry to integrate itself into stronger and more broadly based units, and I welcome the progress that is being made in Britain to this end.

During the year which has elapsed since the last Farnborough Display my Ministry has demonstrated a device with wide international implications and great possibilities for the future of manned flights. This is the Blind Landing system developed by RAE at Bedford by means of which an aircraft can be landed safely and automatically—with no intervention by the pilot—in zero visibility. The value of the device to military and civil airline operations is far reaching and obvious, particularly as aircraft reach forward into higher Mach numbers.

In this year's Display is the *Black Knight* upper atmosphere research rocket which narrowly missed inclusion in last year's show, the successful first firing in Australia being announced on the last day of the Farnborough Display. The rocket has had an unrivalled record of success in its class from the very first firing.

The Farnborough Display is the shop-window of Britain's aircraft industry and *Interavia* is to be congratulated on presenting the Display so fully.

Aubrey Jones

The Rt. Hon.
GEORGE WARD, M.P.
Secretary of State for Air

I am grateful to the Editor for this opportunity to say something about the Royal Air Force today and the future to which we look forward.

The basic roles of the Royal Air Force have not changed, though weapons and strategy have been adapted to modern political and military requirements. Manned aircraft are being supplemented by missiles. Great emphasis is being placed on strategic and tactical mobility.

The primary responsibility of the Royal Air Force is, of course, its contribution to the deterrent to global war. This is provided by the highly trained 'V' bomber squadrons of Bomber Command. The power of the 'V' force will be maintained by the introduction of the Mark 2 *Victors* and *Vulcans* and by their equipment with the powered guided bomb. It will be supplemented by the deployment of the *Blue Streak* intermediate range ballistic missile sited underground.

Meanwhile the deterrent power of the western allies is being further increased by the deployment of Royal Air Force squadrons equipped with *Thor*.

But the strategic deterrent is only one of the Royal Air Force's tasks. Air defence, reconnaissance, tactical operations, patrolling, Army support, transport of troops and equipment, and maritime work are all vitally important in home and overseas theatres.

Day and all-weather squadrons of *Hunters* and *Javelins* defend our deterrent bases against the manned bomber and are also readily available for reinforcement of overseas theatres. The defensive capacity of Fighter Command is being increased with advanced Marks of *Javelin* fitted with reheat, and next year the *Lightning* comes into service. Manned fighter operations are being successfully integrated with operations by the *Bloodhound* S.A.G.W. units now coming into service, and our new radars and control techniques are enabling fighter interceptions to be made far out from our coasts.

Three new types of aircraft have recently been adopted by the Royal Air Force. The T.S.R.2 will be a tactical strike aircraft of highly sophisticated performance which will in due course replace the *Canberra*. The transport force is to be equipped with the Armstrong Whitworth 660 tactical freighter and the *Britannic* strategic freighter. Between 1955 and 1960 the carrying capacity of the transport force will almost have trebled.

The Royal Air Force looks towards the future with confidence. Encouraging progress is being made in the build-up of an all-regular force. The officers, airmen and airwomen of today and the recruits now joining them display the same quality and spirit as their predecessors and can be relied upon to maintain their high traditions of loyalty, courage and skill.

George Ward

Britain's Aircraft Industry Closes its Ranks

I. An Overall Appreciation

By Derek Wood, Interavia's London Editor

The annals of the British aircraft industry will record 1959 as a year of upheaval and reorganization. Announcements of amalgamations and mergers have followed one another in swift succession. Old names have disappeared and new banners have been hoisted.

During the past year and a half fourteen British aircraft and aero engine companies have been involved in mergers and amalgamations. In 1949 there were thirty-three aircraft and sixteen aero engine manufacturers; today there are twenty-three and six respectively, and of this total eighteen are members of groups comprising two or more companies.

This unprecedented "get-together" has been brought about by two major factors: a) Dwindling official orders combined with Government rationalization recommendations and b) the need to improve resources so as to compete in the world markets.

The Fairey *Rotodyne* VTOL aircraft is a prime example of a revolutionary type which cannot be fully developed and exploited without official support. Not until the Ministry of Supply had placed a substantial order which assured its future development was airline interest awakened.

On July 7th in the House of Commons, Prime Minister Harold Macmillan summed up the current situation in these words:

"We all know that the greatest problem which lies before this industry is the possibility and method of widening its markets, both civil and military, since most of the difficulties of the industry can be traced to insufficient orders for those immensely expensive machines to justify and make profitable their undertaking."

The Government had originally hoped that the formation of larger units with more funds would lead to extensive private venture financing of major transport aircraft which would maintain production. In some cases this has been true, as with the *Vanguard,* the VC-10 and up to the time of the Transport Command order, with the *Argosy.* There is, however, little hope of this policy continuing, as foreign customers will not buy until the project has had large scale home development and production backing, and the manufacturers cannot build in the hopes of export orders alone—particularly when a medium-sized airliner costs over £10 million to develop.

It has become clear—and the Government also appreciates—that projects can only succeed where home backing is provided and, in the case of civil aircraft, where civil and military requirements can be aligned to ensure adequate testing and production tooling.

The *Rotodyne* is a particular example of this new thinking. This is a radical project in a class on its own, yet requiring extensive and arduous testing to fit it for the civil market. Fairey could not hope to do all the work and export the aircraft on a private venture basis. Several airlines including BEA were interested, but only if the expensive development was assured officially. Now, with the military contract for the RAF in hand and a line for a minimum of fifty civil and military machines assured at the outset, airline interest in many places abroad is sharpening.

Projects produced solely for the British airline Corporations are not necessarily the best for maximum world sales, although naturally a BEA or BOAC order is firm bed-rock upon which to build. At present there are too many bodies and Government offices which have fingers in the pie, but none with real authority. A top level civil transport policy has long been needed and there is a manifest need in the U.K. for an *overall* advisory body which could assess the world market and collaborate with other countries, particularly the Commonwealth, on their requirements.

Whether Britain should design and manufacture Mach 3 supersonic transports is also a subject of considerable controversy in the U.K. One school of thought insists that such a machine should be built if technical parity is to be maintained with the USA. The other school equally categorically states that the development cost of over £150 million could never be recouped with the small numbers to be built, and considers that the money would be better spent on backing present and future subsonic types to the full. This situation may well be decided on the basis of military supersonic requirements, both bomber and transport, and on possible cooperation with the United States.

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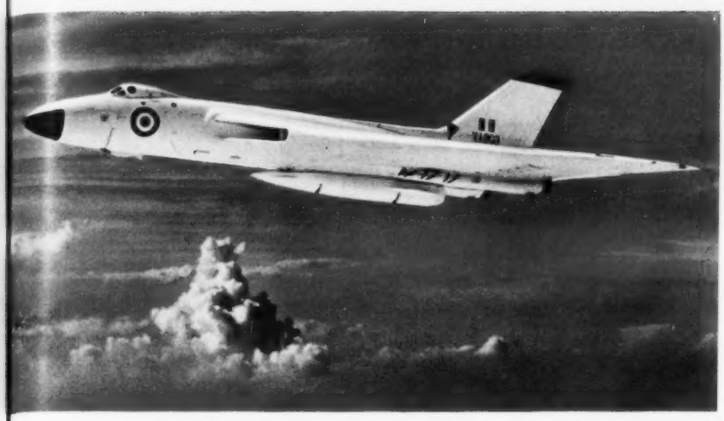
In the sphere of military aircraft the 1957 White Paper on Defence appeared to sound the death knell for manned aircraft and implied the rapid demise of some sections of the industry. In fact many of the forecasts in this controversial document have been nullified by events, and manned aircraft will continue indefinitely although on a much reduced production scale.

Since the beginning of 1958 design and development contracts have been placed for advanced versions of the P.1B *Lightning,* the TSR.2 strike/reconnaissance aircraft, and the Hawker P.1127 VTO light strike aircraft. In addition production of the NA.39, the AW.660 *Argosy,* the Short *Britannic,* the Fairey *Rotodyne* and the Saunders-Roe P.531 has been ordered. Likewise on pure research, work has continued on the Short SC.1 VTO aircraft, while Hunting is working on a jet flap test-bed, and Bristol is completing the Mach 2.5 T.188 research vehicle of stainless steel and ceramics.

Britain is also confronted with the problem of maintaining her traditional exports of military aircraft in the face of increasing subsidized U.S. competition and the closed doors of the French-Italian-German group within NATO. Apart from the supply of engines, Britain is not participating in any of the current NATO programmes, i.e. the military transport, the large helicopter, the light fighter first stage, and the anti-submarine aircraft.



Now that the Ministry of Supply and the Air Ministry have agreed that manned aircraft will be required for a long time to come, the power of the V-bomber force is being maintained by the introduction of new weapons. The Avro *Vulcan* is shown armed with the *Blue Steel* stand-off bomb.

This is obviously unsatisfactory from both the NATO and the U.K. points of view. Britain has the largest industry in Europe with the most expensive and advanced facilities, and the loss of continental Europe to the U.K. is the loss of a traditional market. Many mistakes in approach on both sides have been made in the past, but there are signs of a new cooperation policy. France and Italy have several aircraft and weapons proven, and suitable, for British Service use; and the RAF, Army, and Royal Navy will have to take these into account in future procurement programmes. Similarly Britain has new aircraft designs in the NATO pattern. The Hawker P.1127 lift/thrust engined strike aircraft is nearly two years ahead of any rival in design and development and would exactly fit the replacement requirement for the Fiat G.91.

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Britain's aero-engine industry continues in the forefront of development, but future problems are becoming apparent. To build and develop a new high-performance jet engine, tens of millions of pounds are required, and it is becoming increasingly difficult to attempt such a venture without Government backing. Within the next twelve months decisions will have to be taken on a completely new range of engine projects such as special low consumption turboprops, combined turbojet/ramjets etc, and some form of Government subsidy will be essential if they are to go ahead.

The present U.K. Government is a great deal more "air-minded" than it used to be and is now aware of the need for backing the right projects, both airframe and engine, and of ensuring overseas cooperation wherever possible. The industry will undoubtedly continue to contract in terms of overall manpower as the last of the "old generation" military orders dry up, but its technical future is a great deal healthier than a year ago.

II. Individual Objectives

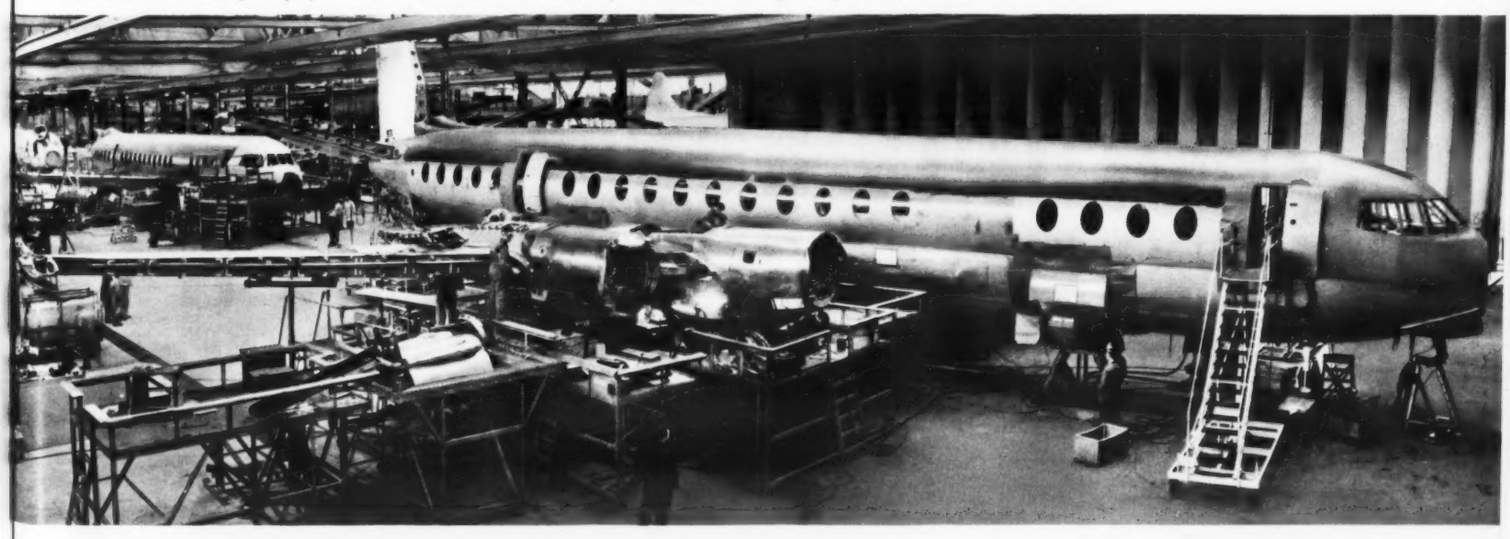
By E. K. Barnes, Interavia, Geneva

Each year the Farnborough SBAC Show appears as the climax of the British aircraft industry's year. It is the shopwindow where current developments and future projects are displayed. Similarly each year it has been the practice of *Interavia* to make a pre-Show review which recapitulates the current activities of the industry broadly and also adds what information is available on future developments and trends.

For the writer the preparation of the 1959 Show review has proved particularly interesting, because after many years spent within the industry itself it has offered the opportunity of visiting a number of individual companies throughout England and of seeing the general pattern of the industry for the first time as an outsider. In a series of visits ranging from London, to Bristol, to Derby, to Coventry, I was able to see a number of companies, both airframe and engine manufacturers, in the throes of preparation for Farnborough; the impression I brought away from England is perhaps best defined by the word *transition*. For it is evident from talking with members of the industry that the uncertainties which commenced with the change of accent from military to civil production are by no means resolved, and the industry is only now finding a field to operate in which offers the best scope for its talents.

Despite this atmosphere of change the present level of business within the industry is encouraging. As against export figures of £ 116 million for 1957, the exports for 1958 totalled £ 154 million—an increase of £ 38 million compared with an increase of £ 12 million from 1956-57. But, together with these record figures, one factor should be taken into account. The industry has been working at full pressure to deliver present generation aircraft from the production lines, and a continuation of this upward trend depends on securing new orders for the next generation aircraft. With the present reluctance among the major airlines to embark on re-equipment programmes for a variety of reasons, the future is not yet clear, despite the strenuous efforts being made by manufacturers in the form of sales tours and demonstrations.

Production of the *Vanguard* propeller turbine airliner is the main activity at Vickers Armstrongs. Forty aircraft have been ordered to date.

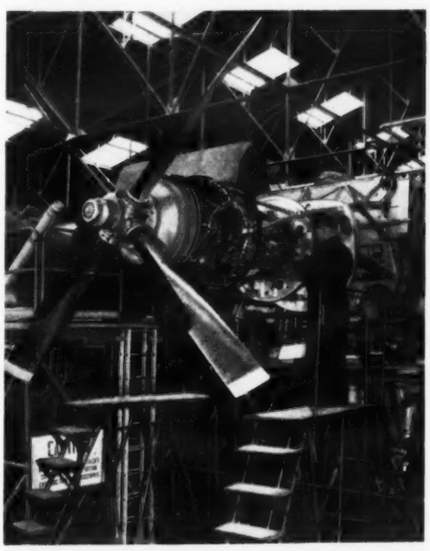


Two generations of turboprop airliners. The Vickers *Viscount 816* in the livery of Trans-Australia Airlines and the second production *Vanguard* on the manufacturers' airfield at Weybridge.

Civil aircraft production and projects

In visiting a number of major constructors engaged in civil aircraft production, I was given sundry illustrations of these difficulties facing the industry. Since the *de Havilland Aircraft Company* introduced the *Comet* the emphasis in this company has been on civil production while military developments have slowed down. At the present moment production of the *Comet 4* is continuing but a slowing down of orders has necessitated staff reductions. Several airlines are known to be in the process of negotiations for the purchase of *Comet 4s,* but details are scanty at present, and the company is obviously unable to maintain employment for a full production staff in the hopes that the negotiations will turn out satisfactorily. De Havillands are understood to be working on a new version, designated *Comet 5,* featuring more powerful engines—possibly Rolls-Royce *Avon* RA.29/5—and a longer fuselage. This new aircraft would offer greater range and capacity than the current model.

In the field of future projects, work is being carried out on a possible DC-3 replacement. This aircraft, the DH.123, is a 28/30 seater to be powered by two *Gnome* engines of 1,000 s.h.p. The most important item in the de Havilland future programme, however, is the construction of the DH.121 jet aircraft for BEA, but unfortunately delays have occurred in finalizing the details of the design. The original requirement was for a 110-seat aircraft, but subsequent studies by the Corporation indicated that a version of smaller size, 100,000 lb all-up weight and seating for a maximum of 90 was preferable. Negotiations have been going ahead between BEA and the Airco combine (de Havilland, Hunting and Fairey) and a contract for the delivery of 24 aircraft in this later configuration has now been signed. It was originally intended to use Rolls-Royce RB. 141 engines to power the larger aircraft; the scaled down version will now be equipped with the RB. 163 of 10,000 lb. thrust and will retain the three engine layout. The RB. 163 is a private venture developed by Rolls-Royce and stems from the RB. 141 family.



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Another manufacturer whose interests are centred chiefly in the civil market is *Vickers Armstrongs (Aircraft) Ltd.* After the success achieved by the *Viscount,* Vickers can now claim to be the most experienced constructors of turboprop transports in the industry. The sales of the *Viscount* have been so widespread that Vickers have decided to maintain a small production line of these aircraft for some considerable time to come, in order to guarantee replacements to the operators.

The main activity of the company is now devoted to production of the *Vanguard.* In visiting this manufacturer I was given examples of the impressive results obtained from the flight trials of this aircraft under representative airline operating conditions, and at the conclusion of a recent sales tour in Canada, the aircraft returned from Gander to the manufacturer's airfield at Wisley in the south of England in the record time of 5 hours 30 minutes. The first seven aircraft to roll off the production line will be Type 951 with

Details of the Armstrong Whitworth AW.650 *Argosy* freighter coach. Left: Installation of the wellknown Rolls-Royce *Dart R.Da 7/2* engine with its Rotol propeller. Lower left: A freight handling demonstration using the rollermat loading system. This enables thirteen tons of prepackaged freight to be loaded and unloaded in fifteen minutes. Below: Preliminary structural inspection of the fuselage after dynamic pressure testing in the water tank.

21,000 lb payload and equipped with 4 Rolls-Royce *Tyne I* turboprop engines (4,985 e.h.p.). Subsequent aircraft will be of a higher gross weight offering 29,000 lb payload and powered by *Tyne II* engines (5,525 e.h.p.) giving even further improved economics. Orders have been received from BEA for 20 aircraft, and from TCA for a further 20.

Work is progressing on the VC-10 long-range jet airliner for BOAC, and fuselage jigs are going up; 35 aircraft have been ordered, and an option taken on a further 20. First flight will be in 1961, and delivery is scheduled to begin in 1963. Four Rolls-Royce *Conway* by-pass turbojets have been chosen to power the aircraft, and it is anticipated that a developed engine of approximately 24,000 lb thrust will be available. Test figures to date indicate that the clean wing configuration of the VC-10, with its high lift coefficient, gives excellent landing and take-off performance, despite a take-off weight of 300,000 lb.

Vickers is also studying a 70 seat jet-engined replacement for the *Viscount*. This aircraft will be a scaled-down version of the VC-10, probably powered by four Bristol Siddeley ducted fan engines.

Although there was a fall in Vickers turnover in 1958, the company is looking to the future with optimism. With the present tendency towards cheap fare policies it is felt that the economics of the *Vanguard* over short and medium hauls and its comparable block times to jet transports will make it extremely attractive to operators throughout the world. There is also the distinct possibility that in the early 1960s the consolidation of requirements for subsonic aircraft will offer scope for expanding business.

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Bristol Aircraft Ltd. also reported lower net profits for 1958, despite record sales figures. This was due to increased outlays on research and development. During the year fifty-one *Britannias* were delivered, and production continues. Operation of the *Britannia* on the air routes of the world has given further indications of the satisfactory economics of the turboprop airliner formula, and its utilization on the BOAC routes in the last year has been particularly profitable.

Looking ahead to the next generation aircraft, the chief Bristol project is the Bristol 205, a 70-seat multijet aircraft for short-range operations. The economics and performance of this aircraft have been discussed with airline managements, but no decision as to its future has been forthcoming. The design and production of helicopters forms an important part of the Bristol activity, and considerable airline interest, particularly on the part of BEA, has been shown in a civil version of the Bristol 192. This twin-rotor machine, powered by two Napier *Gazelle* gas turbine engines of 1,650 s.h.p., is at present in production for the Royal Air Force and represents the outcome of many years' development of tandem rotor craft. Another helicopter project under development at Bristol is the B.124, a 16-seat machine powered by two de Havilland *Gnome* turboshaft engines.

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The transition from military to civil aircraft production is illustrated by the reappearance of Hawker Siddeley Aviation in the field of civil transport. In this instance the firm of *Armstrong Whitworth Aircraft* has become the first member of the group to undertake the production of a

The Future of the A. W. Argosy

By E. D. Keen, B.Sc., F.R.Ae.S., A.F.I.Ae.S.
Chief Designer, Sir W. G. Armstrong Whitworth Aircraft Ltd.

Most of the world's national airlines are heavily committed—many people would say over-committed—to buying long and medium-haul jets. But many of the carriers who operate the shorter routes are looking to the turboprop to bolster their balance sheets in the next ten years.

In the main, these airlines are ruled by hard economics, and although anxious to offer the best service possible, do not become embroiled in prestige races and keeping up with the Jones's. For many of them a wrong decision on major re-equipment could mean extinction.

These, then, are the potential *Argosy* customers—and world-wide there are many of them. They want an aircraft that, after the repayment of capital and interest each year, will show them a greater profit than does their existing equipment; they want simple maintenance and long periods between overhauls, coupled with an established after-sales service; and they want an aircraft that can be absorbed easily into existing route networks and existing airfields—with or without concrete runways.

And, in this era of rapidly-expanding freight traffic, they want a flexible aircraft—an aircraft that can do any job in the short/medium range bracket. It must be capable of carrying a heavy load of bulky freight, or 80 passengers in pressurized comfort, or any combination of the two; and it must have a quick turn-round to build up those all-important flying hours.

In recent *Argosy* freight handling trials, using the new Armstrong Whitworth rollermat loading system, 13½ short tons of palletized freight were unloaded and loaded in 15 minutes—and this included a Rolls-Royce *Dart* engine on its stand. Used as a passenger airliner between London and Paris, for example, the *Argosy's* break-even load factor to cover the total cost of operations is as low as 37 percent.

We believe this break-even figure to be lower than that attainable on any existing transport when operating such short stages.

Already the first five of the initial batch of ten civil *Argosies* have been flight-tested. Certification—both British and American—will be completed by the summer of next year.

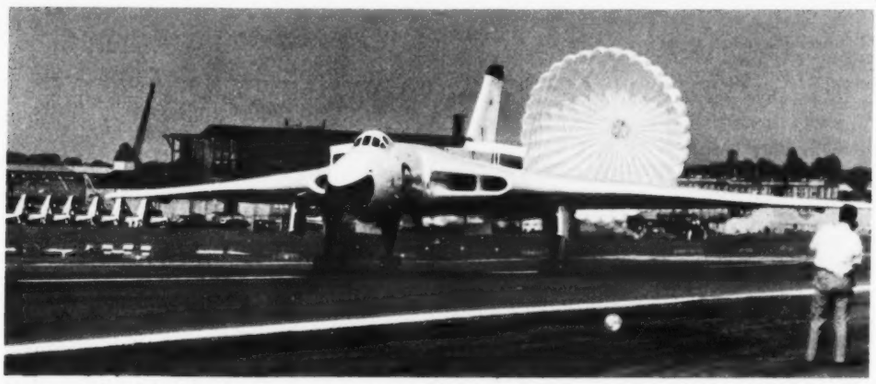
The military potential of the *Argosy* has certainly not been neglected by Hawker Siddeley Aviation, Ltd., which controls Armstrong Whitworth. The RAF has adopted the military *Argosy*—the A.W.660—as its tactical freighter. The first of these aircraft will fly next year, and delivery to squadrons will start soon after. This is the first military freighter/troop transport built in Europe that is fully pressurized and has the refinement of a "beaver tail" that can be opened in flight for supply-dropping. There is, of course, plenty of "stretch" in both the civil and military versions and a ready-made next stage power plant, the *Dart 10*.

Riddle Airlines Inc. of Miami, Florida, have already signed a provisional order for a batch of civil *Argosy* freighters—one of which can do three times the work of one of Riddle's modified C.46's. From the beginning of the *Argosy* programme we were convinced that there was a definite requirement for a transport which could cut costs—and, consequently, fares and freight rates.

Final assembly and flight preparation of the AW.650 *Argosy*.

During the past ten years twenty-three different marks of the *Canberra* have been built. Shown here is the U Mk 10 target aircraft developed by Short Bros. and Harland for unmanned operation in guided weapon firing trials.

Several types of military VTOL aircraft are at present under development. The Short SC.1 research vehicle illustrated above has been flying for some considerable time and indicates the progress that has been made in this technique.



A representative of the V-bomber force. The Avro *Vulcan* is shown making a short landing using the braking parachute at the 1958 Farnborough display.

The manned all-weather fighter still remains the mainstay of air defence. At English Electric the testing of the pre-production batch of twenty P.1B *Lightnings* is well under way and orders for a substantial quantity are in hand.

new turboprop transport. The AW.650 *Argosy* freighter coach is a versatile multipurpose design, powered by four Rolls-Royce *Dart* engines, and considerable interest is being shown in its capabilities. It has already been ordered by Riddle Airlines in the USA and in a military version (AW.660) by Transport Command, RAF. Its economy and versatility will make this aircraft a serious contender in freight/tourist operations. Yet another member company of the group, *A.V. Roe,* whose activities have been predominantly military, is also entering the civil field. Work has been going on for some time on the Avro 748, a short take-off turboprop aircraft in the DC-3 replacement class. Orders have been received for three from the Ministry of Supply, and the aircraft should be flying in 1960. A contract has also been negotiated for the production of 100 aircraft under licence in India.

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The appearance of the *Fairey Aviation Co.* in the civil market marks a departure from a long tradition of military, or to be more accurate, naval aircraft production, and the development of the *Rotodyne* VTOL transport has aroused widespread interest. Although designed primarily as a civil aircraft for intercity service, its development future has been assured in the military field also by the decision to order it in quantity for the Royal Air Force for use as an Army transport. Fortunately this decision may well crystallize the opinions of BEA, who have shown considerable interest in the aircraft for intercity service. Orders for the *Rotodyne* have already been received from New York Airways and Okanagan Air Lines, and I was told that interest has also been expressed by Sabena and Japan Air Lines. The present *Rotodyne* is powered by *Eland* engines, but the production aircraft will be an enlarged 65-seater version equipped with specially developed Rolls-Royce *Tyne* engines with rear compressors. Some detail alterations will also be carried out to fine down the fuselage.

The version for Army use will be equipped to serve either as a transport or as an aerial crane. During my visit to Fairey I was able to see the layout of the crane installation. An idea of its capabilities can be gathered from one of the proposed loads—a vast 105-foot Army bridge. The company is also working hard on the question

of noise levels to make the aircraft more acceptable for civil use, and considerable progress has been achieved on this ever-increasing present-day problem.

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A brief glance at the remaining aircraft manufacturers reveals no revolutionary changes in the course of the past year. At *Handley Page* the initial production batch of *Dart Heralds* is now coming off the line, and plans are being laid for a later development at a higher all-up weight. Work is continuing on laminar flow research, and the possibility still exists that Government money may be forthcoming to finance the construction of the HP.113, a high-speed laminar flow research transport aircraft powered by two Bristol *Orpheus* jet engines. *Hunting Aircraft* has not yet commenced construction of the Hunting 107, though most preliminary design work has been completed for this 48-seater twin-jet short-range transport. Huntings are, however, engaged in the production of a new jet flap research vehicle under a Ministry contract. *Scottish Aviation* continues steadily with production of the *Twin Pioneer*, now in the Mark III version, and the aircraft continues to extend its applications.

Sundry other civilian projects include those of *Aviation Traders* of Southend, which is continuing the conversion of DC-4 aircraft for use as car ferry transports—the completed conversion is termed the ATL 98. *Lancashire Aircraft Corporation* has now taken over the production of the Edgar Percival E.P. 9 agricultural aircraft, and sales are continuing steadily. At Shoreham *F. G. Miles Ltd.* is continuing further development of the *Student*, an extremely attractive and lively jet trainer equipped with a Blackburn-Turboméca *Marboré* engine, which I had the opportunity of flying during the recent Paris Salon. Work has now ceased on the HDM.105 project, but there has been considerable expansion in the field of electronics and simulator design.

Military aircraft production and prospects

Since the 1957 White Paper the pattern of defence policy has become modified with the passing of time, and the manned aircraft, in conjunction with guided weapons, remains the most important part of the Royal Air Force armoury. At the same time, however, the provision of military aircraft is proceeding on a reduced scale and, while many manufacturers are fully engaged on current production contracts, the prospects for future projects are obscure. Perhaps one of the most heavily committed manufacturers in the military field for some time to come is *English Electric*, where the *Lightning* is in full production in both the single-seat and two-seater configurations. A recently-awarded development contract also indicates that further advantage can be taken of increased engine powers now available and of improvements in the weapons system. It would appear logical that, with its capacity, cruising range and performance, this aircraft would also prove suitable as a counter measures platform.

Ten years have elapsed since the first flight of the *Canberra*, but this adaptable and flexible aircraft still continues in production. Twenty-three different marks have been produced to date, and it is now in service with nine air forces. The latest order for a probable 12 aircraft is from the Iraqi Air Force.

Turning to future projects, English Electric is working in conjunction with Vickers-Armstrongs on the TSR.2 contract, and a composite design team drawn from the two companies is now at work in the Vickers factory at Weybridge. This is to be a strike/reconnaissance/interceptor aircraft powered by Bristol Siddeley *Olympus* engines and will have a high altitude performance in the Mach 2.5 class. It is likely to be widely used by the Royal Air Force in the mid-1960s, and its extremely short field performance will make it suitable for utilization throughout the Commonwealth and Colonial territories.

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Vickers' present commitment in the military field consists of production of the *Scimitar* carrier-borne strike fighter, and deliveries to the Royal Navy will continue into next year.

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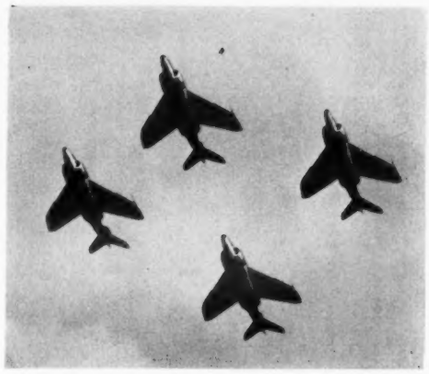
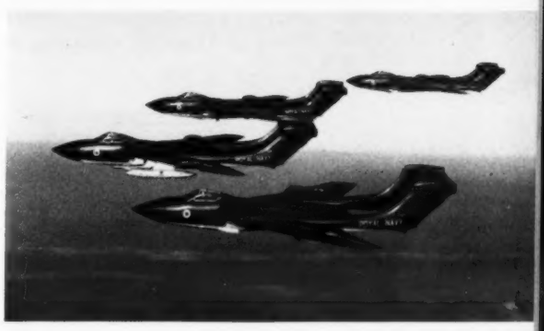
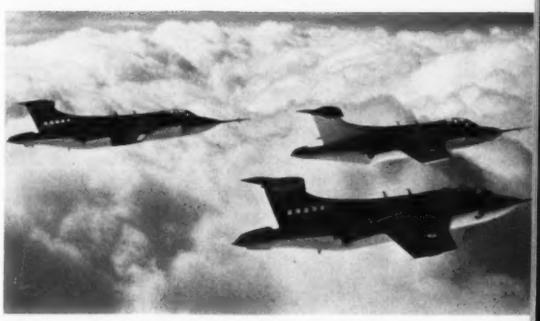
The development of the weapons system concept is exemplified by the programme of *Blackburn and General Aircraft*. The NA.39 carrier-borne low level transonic strike aircraft (two de Havilland *Gyron Junior*) is now in production, and the first six aircraft have already flown. Reports indicate that the test programme is





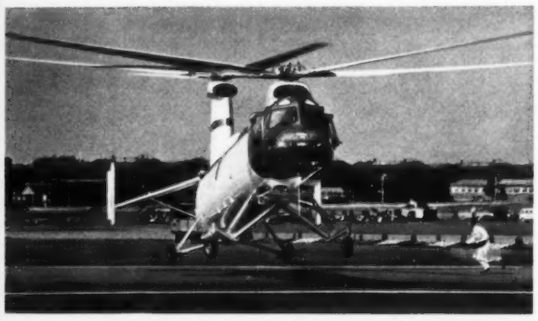


Modernization of the Royal Navy Fleet Air Arm. The Vickers *Scimitar* (top) strike fighter is at present in service, and deliveries will continue into next year. The first squadron to be equipped with the de Havilland *Sea Vixen* (centre) interceptor/attack aircraft has been commissioned, and a further seven squadrons are to be formed. The Blackburn NA.39 (bottom) transonic low level strike aircraft is now being built, and flight trials are in progress on the first six aircraft.

Folland Aircraft, now a member of Hawker Siddeley Aviation, is constructing a pre-production batch of 14 *Gnat* two seater trainers. The small dimensions of the aircraft are apparent from the photographs.

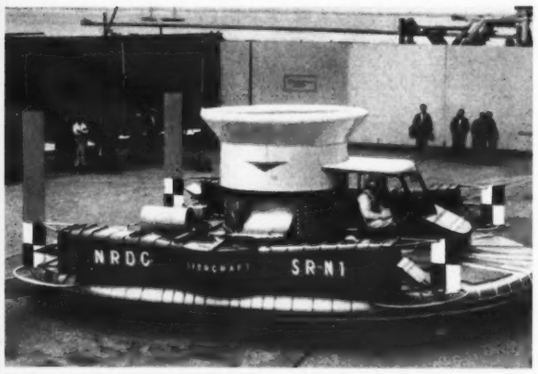
The Westland *Westminster* flying crane transporting an Army bridging pontoon.

The Saunders-Roe P.531, a five seat general purpose helicopter now being developed for the Navy.



The Bristol 192 eighteen seat military helicopter is in production for the Royal Air Force. As a result of interest on the part of BEA a civil version is also being developed.

The Saunders-Roe SR-N1 which recently crossed the Channel from Calais to Dover in two hours three minutes "hovering" time.



progressing satisfactorily, and the special navigation and weapon delivery system is now in the test stages.

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The military activities of the member companies of the Hawker Siddeley group show considerable current production work in hand but not a large number of future projects to follow on. *Hawker Aircraft* continues production of the *Hunter* in the single-seater and two-seater versions and development of a fighter/bomber/recce variant FGA.9 to replace the *Venom*. Development work is continuing on the P.1127, a VTOL lightweight ground attack aircraft of very advanced design using the Bristol Siddeley BE.53 lift/thrust engine. This interesting aircraft is designed to fill a wide variety of roles armed with rockets, bombes or guided A/A weapons, and it is expected to meet the RAF requirement for a short-range light strike aircraft as well as the NATO third stage specification. At *A.V. Roe* the *Vulcan* B.2 (four *Olympus* BOl.7) is rolling off the production line for the equipment of the V-bomber force, while at *Gloster Aircraft* the construction of the *Javelin* FAW Marks 8 and 9 (two *Sapphires* with afterburners) is now being phased out as *Javelin* production nears completion.

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Other military commitments which are still outstanding include the construction of the *Sea Vixen* by *de Havilland*. The first Fleet Air Arm squadron (No. 892) to be equipped with this aircraft was commissioned in July, and it is anticipated that a total of eight squadrons will be similarly equipped. The *Sea Vixen* fulfils a dual role as an interceptor/attack aircraft and it is claimed to be the most advanced all-weather carrier-borne weapons system now in service. In the interceptor role four *Firestreaks* or 124 two-inch rockets can be carried, while for attack the load can consist of rockets, bombs or tactical atomic weapons. It is expected that production will occupy the de Havilland Christchurch factory for the next two years. De Havillands are also to build the Canadian-designed *Beaver* for the Army at their Chester works.

*

The *Fairey* tradition in naval aviation is being maintained with the *Gannet* anti-submarine aircraft. Production continues on this aircraft for export, and despite a recent statement that future British anti-submarine search and strike duties would be carried out by helicopters, three Fleet Air Arm *Gannet* squadrons are being reformed. Production continues of the *Gannet* AEW.3, a radar-equipped version which offers comprehensive long-range search capabilities for carrier operations.

*

At *Follands* the pre-production batch of 14 *Gnat* trainers is under construction, and the first aircraft should be flying at Farnborough. The *Gnat* has been cleared for service in India, and a production order is pending. Interest has also been shown by Yugoslavia in the MK.2 following trials with the MK.1 aircraft. The Mark 2 project with a thinner wing and afterburning Bristol *Orpheus* is still active, and with a performance of Mach 1.4 it has been suggested as a suitable aircraft to fulfil an unsatisfied naval requirement for a supersonic interceptor. The take-over of Follands by Hawker Siddeley, now being negotiated, would widen the scope of future *Gnat* projects.

Hunting Aircraft Ltd. continues with large scale production of the *Jet Provost*, the basic trainer for the Royal Air Force. Latest marks of this aircraft are now being fitted with the *Viper ASV.11* engine. One interesting feature of *Provost* production is that a small but regular flow of orders continues to be received for the piston-engined version, which has meant continuation of a small production line.

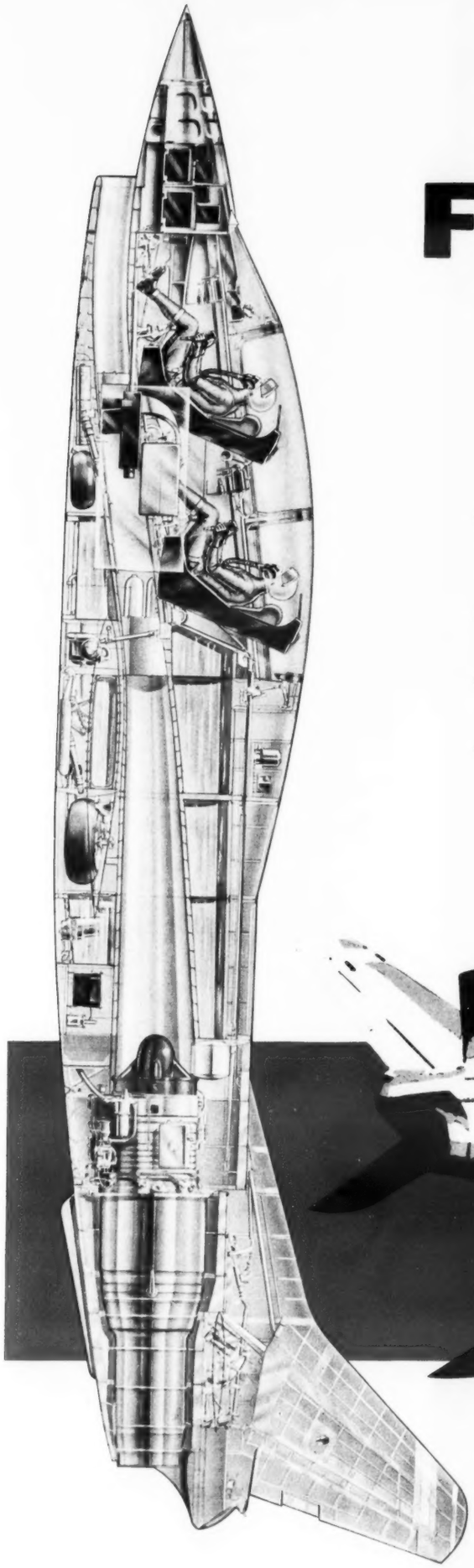
A common trend in future development

At a time when modern aircraft demand more runway space and stronger surfaces it is not surprising to note that most future projects appear to be directed to STOL and VTOL performance. A number of projects mentioned, the Fairey *Rotodyne*, the English Electric/Vickers TSR. 2 and the Hawker P.1127 all fall into this category. Research in this direction has undoubtedly been hastened by the advances which have been made in engine power outputs. One company in particular, *Short Bros. and Harland*, is making vigorous progress in this field and is pressing forward development of the SC.1 also with a view to possible military application. Great interest has been shown in the progress of this aircraft by the consortium of Heinkel, Messerschmitt and Bölkow, who have plans to produce a Mach 2.5 VTOL interceptor with Rolls-Royce engines. In the more conventional field, the current production of the company includes unmanned *Canberra* variants and *Britannias* for Transport Command. Work is also being carried out on the *Britannic*, again for Transport Command; this aircraft should fly in 1961 and is scheduled to be in service by 1963/1964.

Amalgamation

In the course of the past year a number of amalgamations and regroupings have been announced within the industry. The latest move in this process is the purchase of *Saunders-Roe Ltd.* by *Westland Aircraft Ltd.* The immediate result of this merger between two companies whose interests have centred predominantly on helicopters is the formation of the largest helicopter production unit in Europe, a situation which is of obvious advantage in securing future sales.

Prior to the merger Saunders-Roe had successfully produced and tested the *Hovercraft* under contract to the National Research and Development Corporation. Although this novel machine cannot be accurately described as an aircraft, its future development will be carried out within the industry, and a number of companies have made bids to secure development contracts. Its recent Channel crossing on the anniversary of the Blériot Channel flight will be remembered. It is interesting to note in passing that Blériot was considerably the faster of the two pioneers. Other Saunders-Roe activities included production of the new P.531 naval helicopter (one Blackburn *Turmo 600*, 450 s.h.p.) and design work for a higher powered version. Westland Aircraft has been completing the second prototype *Westminster* flying crane (two Napier *Eland 229*) and continuing the development flying programme. Now thanks to the merger Westlands have seven types of helicopter in production or development. It is certain that this concentration of strength is an essential for companies who are facing steadily increasing competition in the world's markets.



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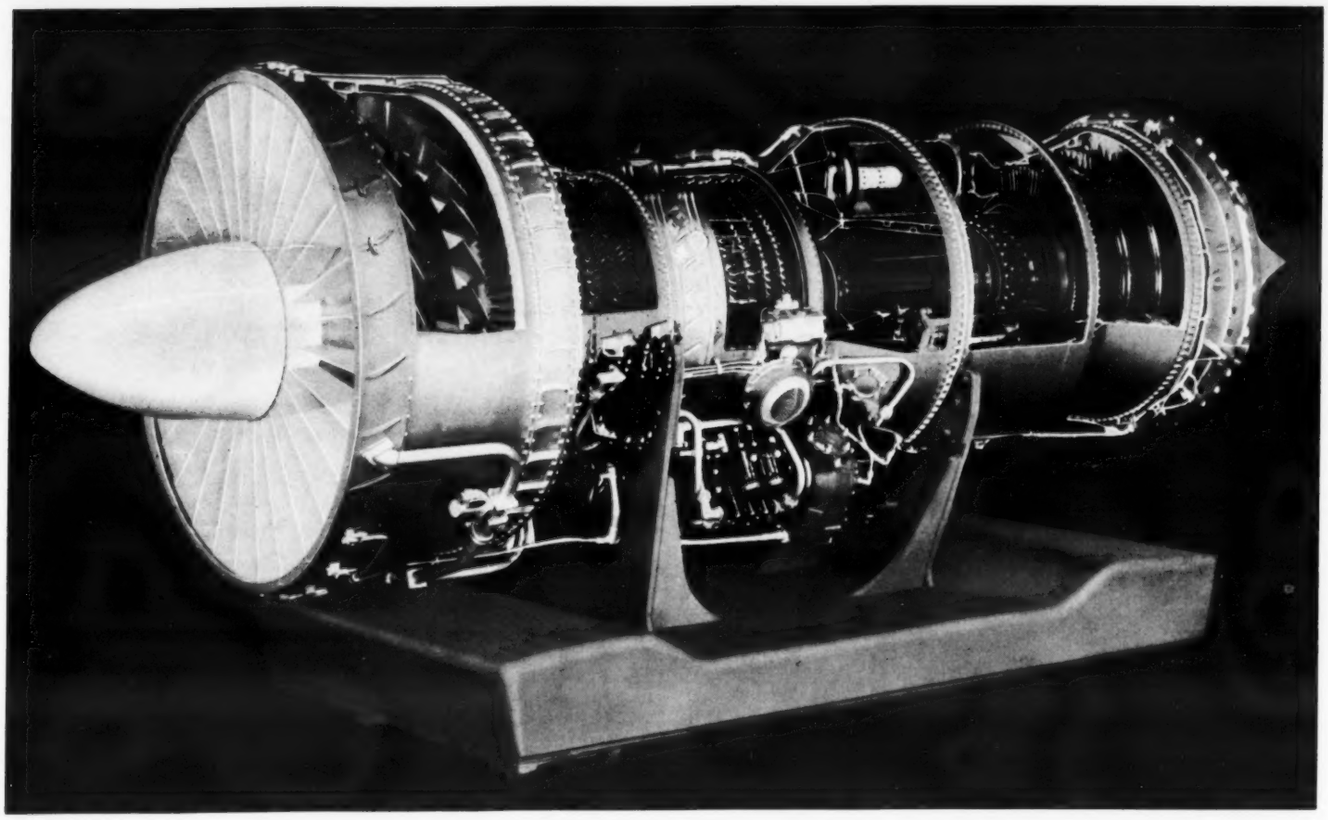

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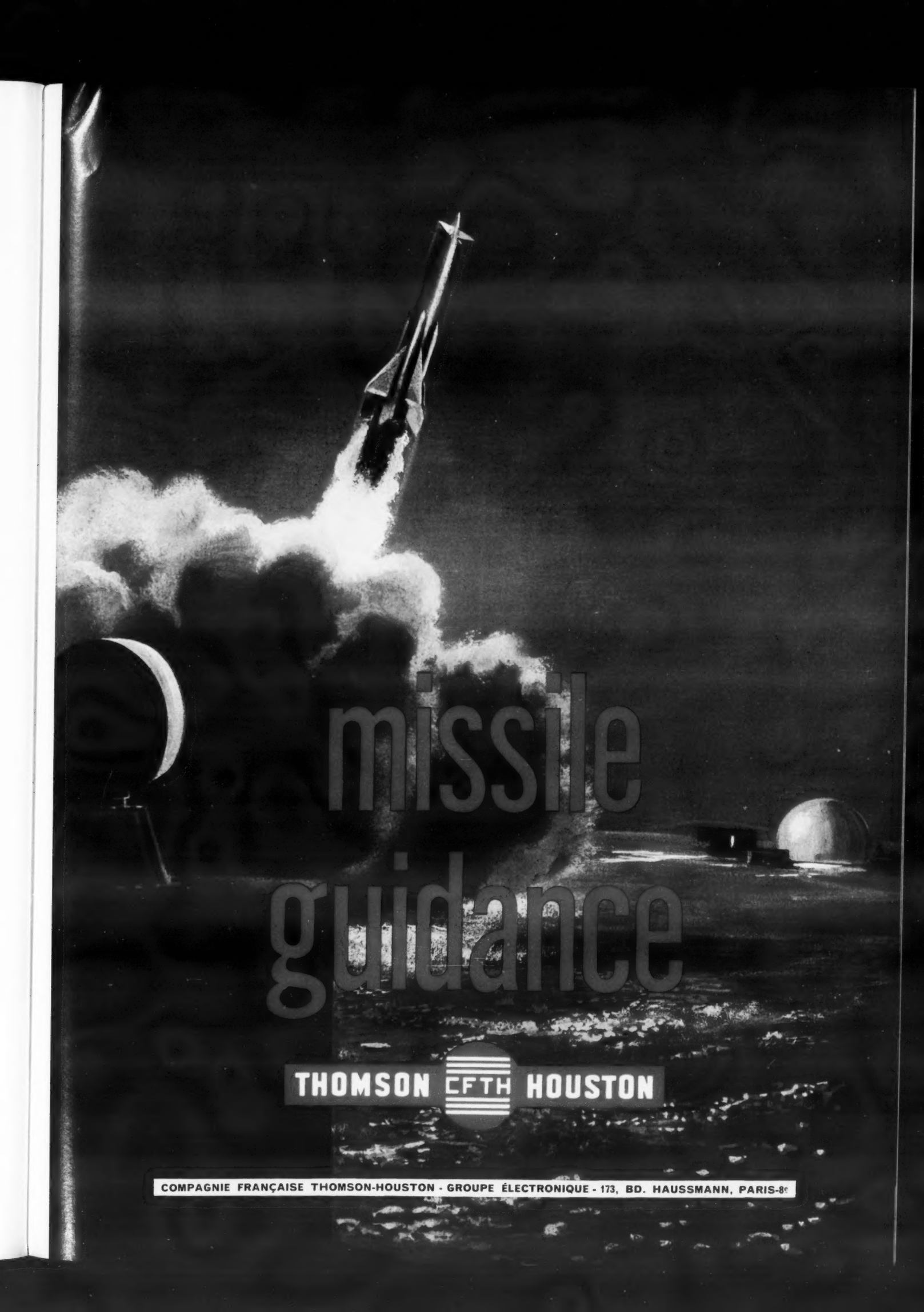
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The moon hangs low in the stratosphere—kingdom of the DC-8

Aircraft engines — still a major export

With change of emphasis from military to civil production the engine manufacturing companies have also been faced with a complicated problem. During a visit to *Rolls-Royce* in Derby I was given some items of information which illustrate this point. The past business year shows another increase in trading revenue, although a substantial increase in expenditure for research and development entailed a reduction in net profits. At the same time the company's success in the export field can be judged from the returns for the aircraft industry as a whole. Out of a total export figure of £154 millions for the entire industry, the export figure for Rolls-Royce engines was £36 millions.

Present engines in production include the military version of the *Avon* for use both by the Royal Air Force and several foreign Air Forces, and the *Conway* for the *Victor B.2*. The civil versions of the *Avon* are in service in the Sud Aviation *Caravelle* and the de Havilland *Comet 4*. Since July 1959 they have been operating with an overhaul life of 1,300 hours. Deliveries are now being made of the civilian version of the *Conway* for the Boeing 707-420 and the Douglas DC-8.

The *Tyne* turboprop is in full production and is in operation on the *Vanguard;* it has also been specified for the CL-44, the *Britannic,* the Franco-German Transall project, the Breguet 1150 A/S aircraft, and in a modified version, the *Rotodyne*. Production is still continuing unabated on the oldest and most famous of them all—the *Dart*—which has now attained an overhaul life of 2,200 hours.

Development work is continuing on engines earmarked for incorporation in next generation aircraft, such as the RB-163 for the DH.121. The *Conway* is also being developed for use in the VC.10 now being built by Vickers for BOAC.

Research on VTO techniques has been a particular Rolls-Royce interest for a considerable time. Since the construction of their research flying test bed — the "Flying Bedstead"—considerable progress has been made in this field. The successful performance of the Short SC.1 powered by five RB.108 engines provides a concrete illustration of achievement in this new sphere of aircraft design.

Missile propulsion is now occupying a greater proportion of the company's effort. A rocket motor based on designs from the Rocketdyne

More Economical New Engines for Airliners

By Dr. S. G. Hooker, OBE, D. Phil., DIC, ARCSc, MIMechE, FRAeS
Technical Director (Aero) of Bristol Siddeley Engines Limited

New civil airliners which are quieter and have a shorter take-off run than present civil jets, and are substantially more economical than the short/medium range aircraft in service today—this is the prospect offered by the use of ducted fan engines.

So far no civil airliner has been built which has the necessary qualities to succeed the *Viscount* turboprop. An aircraft in this category could be expected to have between 50 and 100 tourist-class seats and to cruise at high speed with full payload over stage lengths of up to 1,000 miles. Its maximum stage length, using long-range cruising technique and with somewhat less than maximum payload, would be about 2,000 miles.

The aircraft which are at present used over short/medium-range routes—the *Viscount* and Convair—have been in service for a number of years, and it is natural that the airlines should now begin to look for a successor. This successor will inevitably be jet-propelled and needs to show a noticeable improvement over the existing aircraft in profit-earning capacity. In addition, two operational problems are very much in the forefront at the present time. These are the problem of being able to operate the new machine from present airports without increases in runway length, and the problem of noise in the vicinity of the airports.

The absence of an airliner capable of meeting the operator's requirement is, to a large extent, due to the lack of a suitable engine. The U.S. West Coast manufacturers have for a number of years been trying to interest the airlines in a machine in this category, the powerplants specified being either 15,000 lb to 16,000 lb thrust turbojets for a twin-engined version or 7,000 lb to 8,000 lb thrust turbojets for a four-engined version.

However, none of these proposals proved sufficiently attractive, either economically or as a solution to the runway length or noise problems.

All three of these problems can, however, be overcome by the use of the ducted fan type engine, now being developed concurrently in Great Britain and the USA.

In the area of runway performance, because of its greater mass flow, the ducted fan engine has a higher ratio of take-off thrust to cruising thrust than a straight turbojet; thus, since the engine size is normally selected to provide the desired cruising performance, the ducted fan powered aircraft will have a much higher take-off thrust than the straight jet and a correspondingly shorter take-off run. The latter must be as short as that of the *Viscount* and *Convair*.

Because of its low jet velocity, the high flow ratio ducted fan, as envisaged by Bristol Siddeley Engines Limited, will give a noise level 10 to 15 decibels lower than that of the best existing turbojets. Thus communities living in the vicinity of busy airports will be very much less affected by the operation of airlines using this type of aircraft than by those using aircraft powered by turbojets. In fact, the magnitude of the noise reduction is such that the aircraft noise with the ducted fan will be no worse than that of conventional piston-engined aircraft, in contradistinction to the jet airliner.

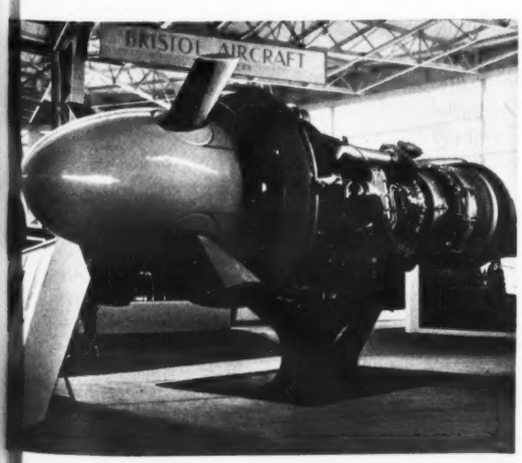
A new type of civil aircraft is always sold on the promise of better operating economics. In other words, using the assumption as to utilization, load factor, etc. which must be made before the machine is placed in service, the aircraft will provide a greater profit potential than its predecessors. This applies equally to jet as well as to piston-engined aircraft.

In the case of the short/medium-range airliners with conventional turbojet engines which have been offered, the promised economics have not been as good as those of the aircraft which they were intended to replace, despite the increase in speed. This no doubt accounts for the lack of interest by the airlines.

Ducted fan powered airliners, however, in the short/medium-range class can offer substantial operating economies over the best airliners now in operation, having both a higher block speed and a lower specific fuel consumption. Because of its better propulsive efficiency, the ducted fan can provide a specific fuel consumption figure under altitude cruising conditions some 10 per cent better than the best turbojet.

Bristol Siddeley has designed ducted fan engines covering a range of thrusts and, although these are new engines, tailored to the needs of civil aircraft, mechanical reliability is expected to be achieved rapidly as a result of the parallel development of military versions. In addition, a large number of the components of both the military and civil engines are identical or closely similar to those proven in tens of thousands of hours service in earlier Bristol Siddeley engines.

The first engine for military application will shortly be on test, and is assured of a great future in the military field.



Rolls-Royce engines accounted for £36 million of the £154 million earned from exports by the British aircraft industry in 1958. The *Tyne* turboprop engine displayed at the 1959 Paris Salon represents the latest production in this type of powerplant.

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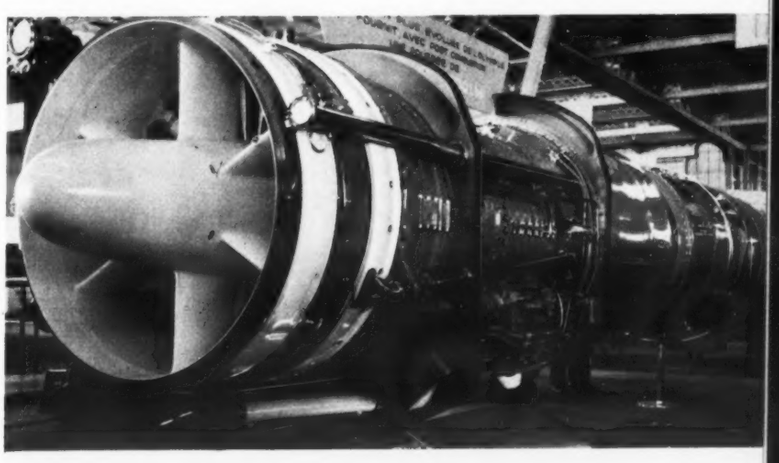
Bristol Siddeley Ltd., formed during the past year by the amalgamation of Bristol Engines and Armstrong Siddeley Ltd., now offers a range of engines covering pure jets, turboprops, ramjets and rockets. The *Olympus* with afterburner is the most powerful example of the range.



Division of North American Aviation Inc. is at present undergoing firing tests in Cumberland. When completed this motor will power the *Blue Streak* long range ballistic missile.

*

During the past year the Bristol Engine Co. amalgamated with Armstrong Siddeley Ltd. to become *Bristol Siddeley Ltd.* As a result this manufacturer can now offer a range of engines which covers virtually every power requirement. Present production includes the *Olympus* 100/200 Series for the *Vulcan B.2,* various marks of *Orpheus* with or without reheat, the *Viper*, and the *Proteus* for the *Britannia.* The *Sapphire* is now being phased out, and the P.181/182 series is likely to be continued mainly in a turboprop version. I was told that future events at Bristol centre around the development of a range of ducted fan engines of extremely low specifics which stem from the BE.53 family.

Studies are also being carried out on the *Olympus* for use in lift/thrust applications, and other work includes investigation of ramjet development, liquid fuel rockets (*Gamma* for *Black Knight*) and turbo ramjets with possible supersonic application.

*

At *D. Napier and Son,* the engine manufacturing member of the English Electric Group, Mr. Hollowell described the efforts being made to promote sales of the *Eland* turboprop engines for conversion of Convair piston engined aircraft. Napiers are confident that a considerable field is open for this process throughout the world, and the *Eland* engine is giving extremely satisfactory results in performance and economy. The *Gazelle* also continues in full production, and the fact that this engine has considerable development potential to much higher power ratings greatly extends its applications.

*

The Engine Division of *Blackburn and General Aircraft* is continuing the production of a range of light gas turbine engines for a variety of applications. This includes a standard starter trolley, an aircraft auxiliary powerplant as fitted in the *Victor B.2,* the A.129 free turbine and the *Turmo 600* engine.

*

A review of British engine manufacturers would be incomplete without mention of *Alvis Ltd.* When I visited Coventry I was taken round the factory by George Wiltsher and came away with the impression that the motto here may well be "specialization by diversification". Although, in terms of numerical production, the second largest engine constructor in the U.K., Alvis does not confine its interests to the aircraft industry; production also includes armoured and fire fighting vehicles, and motor cars for the domestic market. Thanks to the reliability and flexibility of the *Leonides* and *Leonides Major,* these engines are now being employed in an ever increasing number of fixed wing and helicopter models.

Black Knight. The 35-foot ballistic rocket developed for upper atmosphere research. Powered by the Bristol Siddeley *Gamma* rocket motor.

Missile progress

Leaving manned aircraft construction and turning to missiles, the last two years have seen a rapid increase in the number of British designed and manufactured missiles on display. The variety of types now under construction extends from anti-tank weapons to an LRBM. Since the last Farnborough show little information has come to light concerning possible new developments, but further details have become available concerning existing weapons. The *de Havilland Propeller/Rolls-Royce/Sperry* combination is pressing forward with construction of the inertial guidance *Blue Streak* LRBM, and firing trials will take place at Woomera in the coming year. The *Firestreak* air-to-air weapon built by de Havilland Propellers is now in RAF service, and a further version of greater capability is undergoing development. *English Electric Guided Weapon Division* is continuing development of the *Thunderbird* anti-aircraft missile, which is now operational. The latest version will presumably make use of the latest CW techniques. It has also been suggested that this manufacturer is engaged in the design of the short range ballistic artillery weapon for Army deployment. *Short Bros. and Harland* will display the *Seacat* ship-to-air anti-aircraft missile which they have developed from the SXA.5 test vehicle. This short range low altitude weapon is a simple, inexpensive naval defence system which will replace the Bofors gun for ship defence. Considerable interest has been shown in the system by both Scandinavia and Germany.

Details necessarily remain brief on the capabilities and power of most of these missiles, which are becoming current equipment in the national defence armoury. Mention should be made, however, of the winged rocket-propelled stand-off bomb—*Blue Steel*—with Doppler/inertial guidance which will form the main armament of the V-bomber force. Developments continue with this weapon to increase range and power.

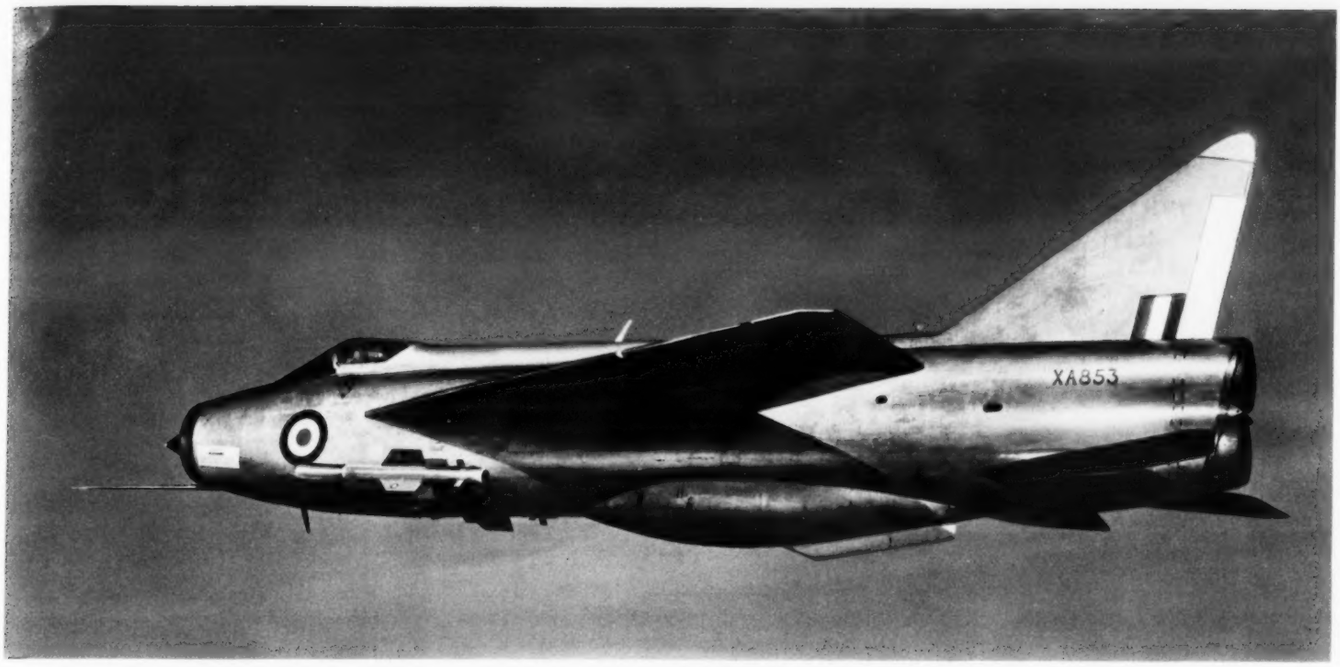
The growth of a missile industry has also stimulated developments in electronics and guidance techniques. Each year the number of exhibits in this classification increases, and in a review of British aircraft construction it is not possible to include comment on this rapidly expanding industry. But the visitor to Farnborough whose interests lie in this particular direction will find a great deal to occupy his attention, with equipment ranging from navigation aids to blind landing equipment for manned aircraft, and from radar guidance to inertial guidance for missiles.

Looking ahead

A review of an industry always concludes with one question—what of the future? Perhaps this question is best answered by spokesmen from the industry itself. The general impression I brought away from England was that, though there is a tough fight ahead, industry leaders are facing the future with continued optimism. Both Sir George Edwards of Vickers and Peter Masefield of Bristol Aircraft, for example, insisted that there are still specialized fields which the British industry can exploit, provided that maximum resources are put behind the chosen ventures. The trend towards lower fares, or at least a fare differential structure, offers plenty of opportunity in the subsonic aircraft category, and the designers have all the technical experience needed to score in this sector of the market. Engine manufacturers, too, will find that the low cost air travel development will support their programme of producing the economical engines with very long overhaul lives which will be essential for the workhorse aircraft of the future.

These, then, are the two patterns within which the industry's future programmes will in all probability begin to take shape.

The English Electric *Thunderbird* weapons system shows its mobility. The ground-to-air missile and supporting equipment are seen being transported by road in Northern France to a NATO demonstration at Versailles.



The Lightning Weapons System

By Derek Wood, Interavia's London Editor

Early in 1961 the RAF will form its first squadron of supersonic all-weather interceptors, equipped with English Electric P.1B *Lightnings*.

For the RAF this is the opening of a new era, because the *Lightning* is not just another radar equipped fighter but a complete weapons system with interlinked radar, weapons, flying controls and instruments and a variety of means of attack.

From now on the pilots of Fighter Command will no longer be fighter "jockeys" of the old type, but commanders of weapons platforms as complex in their conception and production as the latest "V" bombers.

For English Electric and their associates on the *Lightning*, RAF squadron service will be the culmination of years of labour and breaking new ground, as they have produced not only Britain's first fighter weapons system, but the first of its kind which is truly supersonic, and in fact capable of Mach 2 plus.

*

The P.1 itself did not start off as a weapons system, but arose initially from a requirement issued in 1947 for a high-speed research vehicle. In 1949 the English Electric proposal, which envisaged eventual development in a fighter role, was accepted. The speed requirement at the time was modest, being in the Mach 1.2–1.3 category.

From the outset wing design and engine positioning were crucial factors. English Electric studied every known high-speed wing layout, including sharp deltas, blunt deltas, conventional sweepback and thin straight wings. From calculations and wind-tunnel tests it became apparent that a new approach was needed if speed was to be attained while retaining altitude performance and a high degree of manoeuvrability.

Accordingly a "notched delta" was evolved with 60 degree sweep and a low thickness/chord ratio. The notch itself was in effect moved aft to form a low-set all-moving tailplane which gave good longitudinal control.

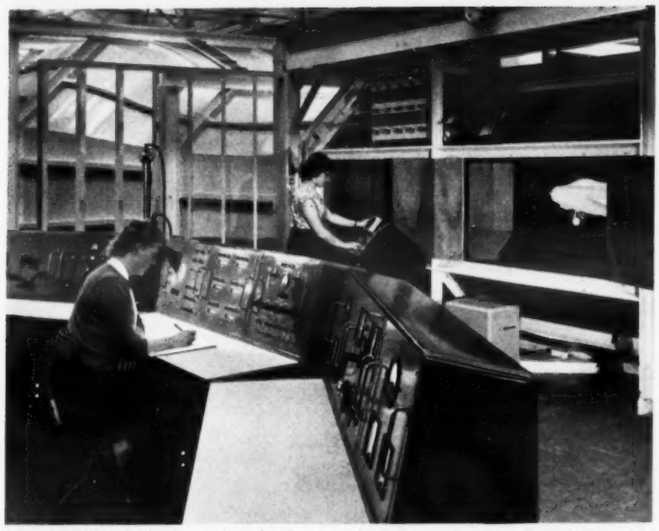
The ailerons were positioned at 90 degrees to the airflow which gave far better control than those on the slanted trailing edge of wings with less sweep, and avoided unpleasant tip stall characteristics.

Tunnel tests also showed that the notched delta had improved drag characteristics over normal deltas.

To avoid asymmetric problems and the thick fuselage cross section necessitated by side-by-side engine installations, the two turbojets were positioned one above the other in the rear fuselage, fed by a pitot type nose intake.

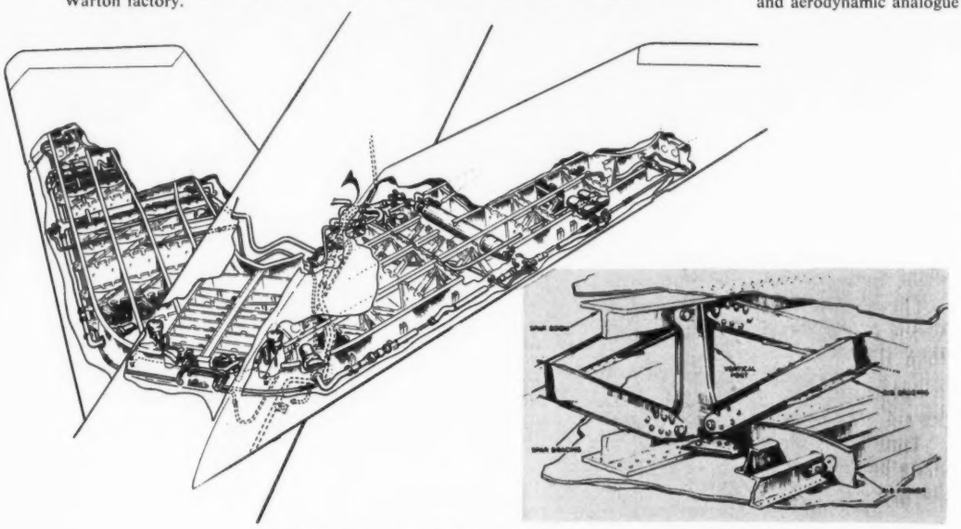
Intensive wind tunnel and general research work continued as the design progressed, and a contract was placed by the Ministry of Supply with Short Brothers and Harland for a *Derwent*-powered research aircraft scaled from the P.1 to evaluate low-speed performance. This machine, the SB.5, flew in December 1952, and was tested with varying degrees of sweep and several leading edge configurations. A good deal of very useful information was obtained from this, but the only problem in assessment was that while the P.1 had powered controls, the SB.5 had manual.

Electrical function tests being carried out on a *Lightning* P.1B armed with D.H. *Firestreak* missiles.



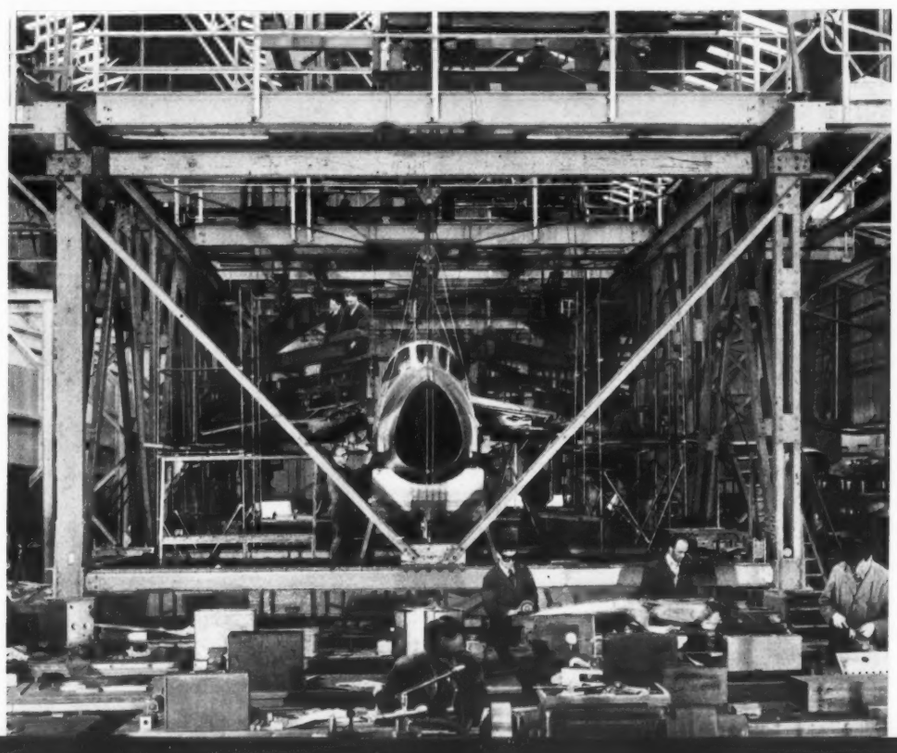
A model of the *Lightning* undergoing low speed wind tunnel tests at English Electric's Warton factory.

Flight performance assessment being carried out with the aid of the flight simulator and aerodynamic analogue computer.



A schematic drawing of the layout of the five spar notched delta wing showing the centre section joint and details of the integral tankage fuel system. (Right): Details of the rib and spar bracing in the interior structure.

The third prototype P.1A undergoing structural strength tests in the rig at Warton.



Instead of early mark *Avons* for the P.1, two *Sapphire 8s* were substituted, and two-position reheat was specified. The then Armstrong Siddeley Company carried out full static tests at Coventry with a complete engine and intake rig.

In the meantime, Air Staff thinking was changing in the light of new threats developing. First the P.1 was committed to a day fighter role with *Aden* guns, and then the really big decision was taken in 1954 to evolve a fully all-weather "weapons system" with air interception (A.I.) radar, guided weapons etc. interlinked with the new radar defence layout.

Thus English Electric was faced with an entirely new concept, and the P.1A when it flew on August 4th, 1954 was virtually the aerodynamic test vehicle for a new project.

*

The P.1A quickly proved that the company's theories and layout were correct and that performance was in excess of requirements. Wing Commander Beamont on the first flight exceeded the speed of sound straight and level, and shortly afterwards went supersonic on climb (without afterburning). A second prototype with two *Aden* guns was built, and these two P.1As in under three years development work made over 500 flights, the majority of them involving supersonic speeds.

A third static prototype was built and tested in the structural rig at Warton.

To meet the all-weather requirement English Electric had to re-design the fuselage to accommodate a mass of electronic equipment, develop a new intake, replace the *Sapphire* with advanced Rolls-Royce *Avons* with variable afterburning and still leave room for new or enlarged items as interception techniques improved.

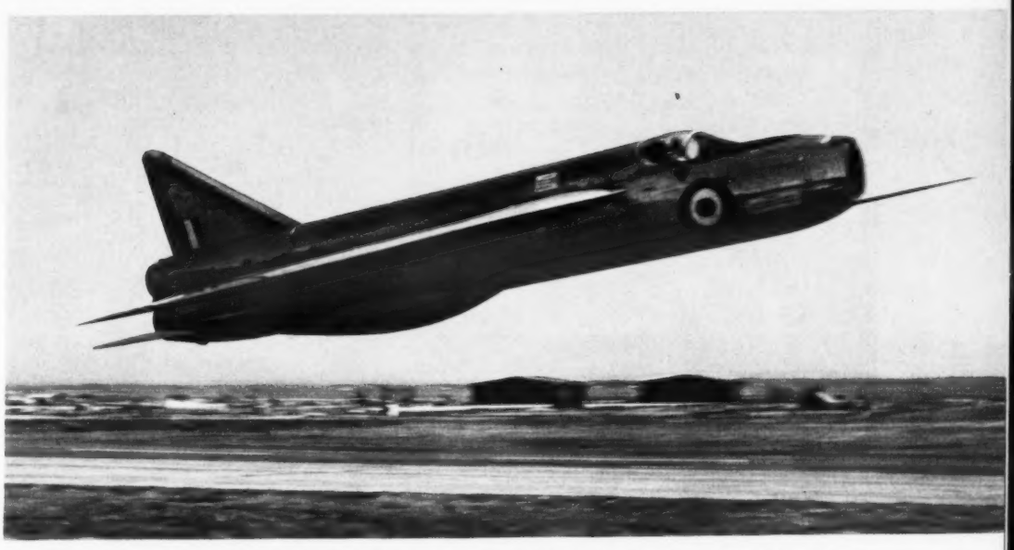
*

The major companies chosen to work with English Electric on what was to become the

P.1B *Lightning FAW.1,* were Rolls-Royce with the *Avon,* Ferranti with *Airpass* airborne radar, and de Havilland Propellers with *Firestreak* infra-red guided weapons, plus other contractors on autopilots, electronics and instruments.

For the aircraft designer this meant constantly looking at the project from the weapons, radar or control angles and not just from the pure flying vehicle aspect. Snags in the weapons could affect the airframe, while added black boxes altered the interior space required.

Put in simple terms the problem was and is to ensure that equipment design and development keep pace with the aircraft and vice versa. Through "this cauldron of design, developing, and intelligent dreaming" as one engineer put it, Britain, in one fell swoop, had



One of the prototype P.1A aircraft on take-off. In three years the two prototype aircraft made over 500 flights, the majority at supersonic speeds.

The vertical layout of the two afterburning engines overcomes problems of asymmetric thrust and reduces the fuselage cross section. Note the low-set all-moving tailplane.

to catch up with and if possible surpass weapons system ideas being pursued by many firms in the USA. This was no easy task as in Britain the jump was from conventional subsonic day fighters with cannon, straight to a Mach 2 "all-seeing, all-hearing, all-speaking" weapons system, missing out two generations of development and operation.

*

If a weapons system is to achieve perfection it must be a completely cooperative effort working step-by-step to complete mechanical and fighting efficiency.

From the outset, English Electric as the weapons system coordinator, realized that the days of taking a black box off the shelf and just fitting it into an aeroplane had gone for ever. The aircraft had to be designed to the weapons and the weapons to the A.I. radar, and so on. Also, the days when people could change their minds on weapons or A.I. equipment in mid-stream had gone.

To speed development which had always lagged painfully in the period of ordering one or two prototypes only, the Ministry of Supply placed contracts for three prototypes of the P.1B and 20 pre-production aircraft. In this way simultaneous testing of engines, radar, autopilot, controls, armament and other systems could be done on individual aircraft, and the results fed back into the machines taking shape on the production line.

From the P.1A English Electric retained the wings, fin, tailplane, powered controls and undercarriage, but the fuselage was tailored to a new section while still fully area ruled. The pitot intake was replaced by a conical body housing the *Airpass* radar and designed to reduce the supersonic air to the correct subsonic velocity at the compressor intake. A great deal of research work was done by both English Electric and Rolls-Royce on the intake, engine installation, afterburning and engine controls.

Three wind tunnels at Warton, one low-speed and two high-speed, were used plus a water tunnel, while other tests were carried out at Ministry establishments. A wide variety of structural systems, control, pressurization and refrigeration rigs were built at Warton, covering every phase of the aircraft's operation.

Much of the basic calculating was done on an English Electric *Deuce* analogue computer, while a manned simulator carried out flight research into numerous aspects of control and handling, with a digital computer feeding in the pre-set plan.

Apart from wind tunnels, supersonic flight data were also gathered from scale models mounted on solid fuel booster rockets and

With airbrakes open and wheels and flaps down a P.1B turns in to land.

The AIRPASS radome being fitted in the modified *Dakota*.

AIRPASS
a Ferranti Airborne Radar Equipment

AIRPASS stands for Airborne Interception Radar and Pilot's Attack Sight System. The two basic components, the A.I. radar and the attack sight, have been developed as a complete equipment, to enable a fighter pilot to find and destroy his target, even though it may be invisible to him and travelling at supersonic speed. The radar is a powerful search-and-track set, and includes a computer for working out the correct course for the fighter to follow, in order to reach a suitable position for the final attack. This information is presented to the pilot in his sight, which also ensures that the weapons carried by his fighter are aimed correctly.

During the search phase, the radar scans a sector of sky covering a wide angle horizontally and vertically on either side of the flight path, and extending many miles ahead of the fighter. When the pilot detects a target in this sector, he can make the radar beam "lock-on" to the target. The radar will then track it automatically, and the approach computer will start to operate.

Once the radar has started to track the target, all the information required to complete the interception is presented to the pilot, who can carry out "blind" attacks using this equipment. Provision is also made for visual attack, should that be desirable. As a precaution, a warning light is provided to tell the pilot to break off the attack, should he approach close enough to be in danger of colliding with the target.

Ground radar is still invaluable for directing the fighters towards their targets, but because of the increased speeds of modern aircraft it is not always sufficient to ensure visual contact. Even if the pilot could be directed accurately to within visual range, he would not necessarily be able to press home an attack. This is because modern weapons can be fired at longer ranges, and modern interceptors at high altitudes need more room to manœuvre, in order to reach a position from which the weapons can be fired. There is, therefore, an essential requirement for search-and-track radar in the fighter itself, to allow the pilot to detect the enemy at long range, after the ground radar has set him in the right general direction.

The Pilot's Attack Sight has been designed from the start to present information from the radar directly to the pilot, and to permit "blind" interceptions and attacks. By using this sight and the very advanced A.I. radar, AIRPASS has made it possible to dispense with a separate radar operator, and the single-seat interceptor is now equally suitable as a fighter for day or night.

In the P.1B, the radar is housed as a single unit inside the centre body of the engine airintake. Although this raised some mechanical design problems in the early stages, it has ensured that the radar is a very compact unit. In fact, although AIRPASS is one of the most advanced fire-control systems in the world, it is small enough to be fitted even in lightweight fighters.

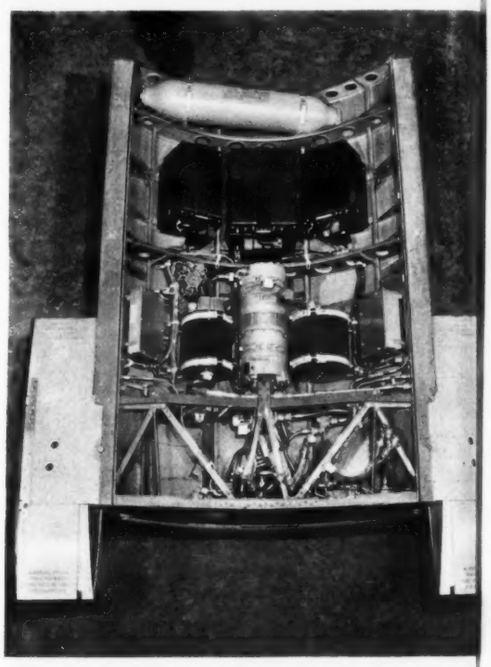
An equipment such as AIRPASS requires a considerable amount of flight-testing, and this has been the responsibility of Ferranti's Edinburgh Trials and Installation Division. Preliminary trials were carried out in a *Dakota* aircraft, with the radar fitted in the nose. In this flying laboratory, a number of engineers and a considerable amount of instrumentation could be carried on each flight, although the aircraft performance was naturally far from P.1 standards. For advanced trials under more nearly operational conditions, a modified Canberra B8 was used. The front fuselage was redesigned and lengthened to accommodate the radar, and the cockpit was made as similar as possible to that of the P.1B, with the complete AIRPASS installation under pilot control. Two crew members could be carried as well as the pilot, one of them being provided with duplicate radar controls, and the other operating various items of recording gear and instrumentation.

A production AIRPASS radome being fitted in the modified *Canberra* B8 for flight trials.

fired from a British weapons range—the results being telemetered to the ground.

On April 4th, 1957, the prototype P.1B *Lightning* flew and quickly proved that it had lost none of the handling qualities of the P.1A, and had a true top speed around Mach 2. Throughout, the P.1s have been completely viceless on transition from subsonic to supersonic speeds with no pitch-up and virtually no indication to the pilot that he has "gone through the barrier" apart from the needle on the Machmeter.

*



The ventral missile equipment pack containing power supply, fire control system and compressed air cooling bottle. The missiles are mounted on the two horizontal pylons.

The task with the prototype and pre-production aircraft was now to actually fly, as a co-ordinated whole, the systems laboriously worked out over the years. Here it is necessary to outline the task of the radar and weapon firms.

The *Airpass* radar has been developed by Ferranti Ltd. of Edinburgh, and its specification called for long range at high altitude, connection with the ground defence system, and linkage with the guided weapons.

The scanner in the intake cone gives information to the pilot in simple usable form, enabling him to pick up the target and lock the beam onto it, after which the radar continues tracking automatically. The information passed to the sighting system is precomputed and enables the pilot to get into the best position for whatever armament he is using, i.e. guns, air-air rockets or guided weapons. He may in fact never see the target he is attacking. *Airpass* "looks" over a wide angle horizontally and vertically and being in the nose centre has little cut-out problem.

If there should be a black box failure or should the pilot so wish, he can use normal visual sighting methods. In addition a warning

Ground firing trials of the *Firestreak* missile from a mock-up fuselage set up at 90° from the normal.

switch is actuated if the pilot approaches too close to the target and is in danger of collision.

Ferranti have built the latest link techniques into *Airpass* and have undoubtedly provided full countermeasures features in the equipment. Security, however, precludes release of any details.

*

De Havilland Propellers started work on the *Blue Jay* or *Firestreak* infra-red (heat) homing weapon in 1951. Initially it was to have formed the equipment of converted *Hunters*, but this scheme was dropped as requirements changed, and it became the standard weapon for the P.1. At this early stage *Firestreak* was intended for subsonic types, but after doing some crystal gazing de Havilland decided on a design to meet the needs of a supersonic carrier.

There are considerable problems in launching air-to-air weapons from a supersonic platform at altitude. To ensure optimum performance a complete analysis had to be made of the actual operational speeds and heights at which the P.1 would fight, as opposed to its optimum performance as a clean airframe. Also, with an infra-red weapon it is vital to combine material strength with the best possible infra-red reception.

To obtain best results the maximum co-operation between the radar and weapon contractors and between them and the coordinator has been essential.

The positioning of the weapons involved much thought, and the final arrangement on the fuselage sides (on two short horizontal pylons) has resulted in minimum length of connections and wiring between the launching shoe and other systems, and a minimum of distortion at high Mach numbers—often found on wingtip and underwing installations. Before launching trials commenced, a good deal of research was accomplished to establish the effect of the lift of the missile fins on the P.1's stability.

The missile itself went through an exhaustive series of proving tests in the United Kingdom and at Woomera, and many hundreds of rounds were fired from aircraft such as the *Sabre*. Among problems sorted out were the effects the sun had on the infra-red homing head and the evolution of an efficient miss distance infra-red fuse.

Firestreak 1, now in service and to be fitted to the *Lightning* has, as recently displayed, a multi-triangular paned nose containing the freemounted "scanner". The infra-red fuse apparently consists of two peripheral windows which provide a triangle with the apex on the target. At maximum heat reception from the target source the windows presumably balance out and fire the warhead which is situated aft.

Each *Firestreak* is attached to its launching shoe on the horizontal pylon by guides which engage with rails on the shoe. Locking is by a bolt which shears under the load of the rocket motor. The two pylons and their shoes form the external parts of an integrated missile equipment pack in the aircraft fuselage which contains power supplies, missile fire control system, and a compressed air bottle for cooling. One box of the fire control equipment is known as the launching sequence unit and contains comprehensive equipment to control and monitor the actual firing.

Before *Firestreak* air-air firings on the *Lightning* were actually commenced, a special rig was set up by English Electric at Aberporth in Wales.

*

Having now integrated the complete weapons system, English Electric is producing, assembling and testing *Lightnings* at three plants, Preston, Samlesbury and Warton.

Flight testing the first prototype of the P.11 two seater *Lightning*.

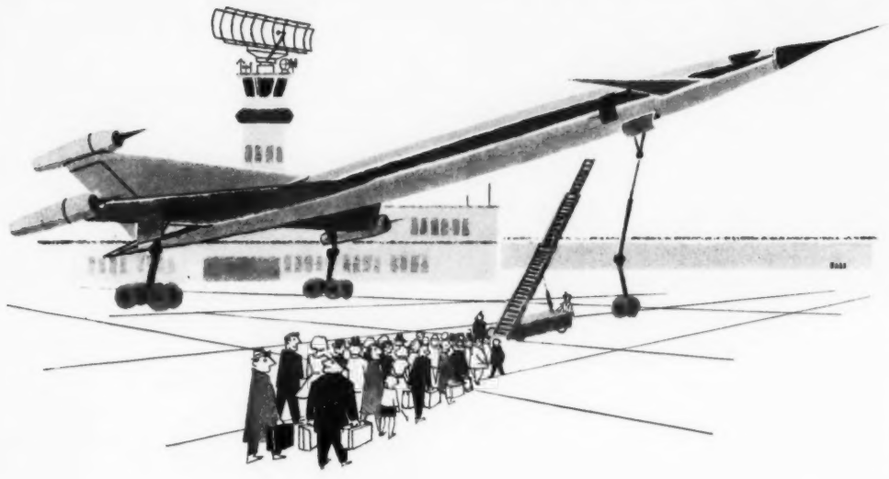
Central Fighter Establishment has been doing operational handling, and Boscombe Down complete final acceptance trials.

In 1961 the RAF will therefore receive a fighter system which has been more thoroughly tested than anything Fighter Command has known previously. They will have a machine capable of exceptional rates of climb to operational altitudes above 50,000 ft., a speed of around Mach 2 and a weapons system "which will be among the most advanced systems for air defence anywhere in the world". Alongside it will be the P.11 two-seat advanced trainer variant which may also appear in a fighter role.

Nor is this the end of the story. Despite the prognostications of the 1957 White Paper on Defence, new versions of the *Lightning* are now under way, apparently with higher thrust engines, improved *Airpass*, and a more sophisticated development of the *Firestreak*.

With their exceptional experience, English Electric, Rolls-Royce, Ferranti and de Havilland Propellers will be able to continue a steady line of *Lightning* development which may cover a ten year cycle and rival its illustrious predecessor, the *Canberra*.

The prototype P.1B with modified air intake using the braking parachute on landing.



In the Supersonic Seventies

By Peter Masefield, M.A., C.I.Mech.E., FRAeS., FIAS., M.Inst.I
Managing Director, Bristol Aircraft Ltd.

The year is 1970.

The 100 passengers for New York have just arrived at London Airport aboard the sleek monorail which left Victoria Station just 15 minutes ago. Now their baggage is going aboard the lithe, steel, arrowlike airliner, waiting at the ramp.

Baggage loading is, in these days, a much more streamlined business than it was a decade ago. And outwards Customs clearance has, at last, been abandoned. Terminal delays, so much a bugbear of the '50s and '60s, have been reduced to small proportions—as indeed they have to be, when the airborne time between London Airport and Idlewild is cut to just over two hours. With London's new terminal buildings at long last completed, Air Transport is now—in 1970—really beginning to get established.

Now that supersonic travel—at Mach 3.5, 2,000 knots, 3,700 km/h—is an everyday event for premium-fare passengers, one can see what a difference it makes to the tempo of world affairs where time is, indeed, money. It has made possible, also, the economic development of subsonic air transport at fares much lower than were believed possible in the early turbine era of the 1950s.

In fact, as the 100 supersonic passengers for New York go aboard their aircraft, the parallel departing Low Fare ("Loafair") fan-jet aeroplane is also loading at the next ramp. Its flying time will be seven and a quarter hours to New York—more than three times longer than our "Supersonica". But, for its 300 passengers, its fares will be only half.

"The Great Divide"—high speed, premium fares/lower speeds, lower fares—has been some time a-coming. But now it is established, air travel is catering adequately for the two main divisions of the travelling public—those to whom the shortest possible journey is of the greatest possible advantage—and those to whom a low fare is more important than a few hours.

So, as the two New York bound aircraft taxi out (commercial vertical take-off is still some years ahead) one to land in two hours, the other in seven—it is interesting to look back historically at the comparison of today's, 1970, times with those of the early jet flights of ten years ago—when the old Boeing 707 was the "last word".

The 1960 timetables, with those of today, make an amusing contrast.

Those early jets, in 1960, suffered of course from the fact that they made one scheduled refuelling stop when flying Westbound. In the opposite direction their scheduled time of 6 hours 55 minutes, non-stop, showed a notable improvement.

Even so, the saving of 1 hour 50 minutes in ground time between city centres is one of the most significant contributions during the ten years. It is the equivalent of adding 50 m.p.h. on to the speed of jet-travel between city centres in 1960 or, had the old surface times remained, would have reduced the speeds between city centres in 1970 by 330 m.p.h.

By now, the "Supersonica" is taking-off, with that short run more reminiscent of the old DC-3 than of the early commercial jets. It climbs steeply at Mach 0.9 to 40,000 ft. Twelve minutes after take-off and 200 miles on its way, out over the sea, the aircraft climbs through the "Sound Barrier". Mach 2 is passed at 60,000 feet. Four minutes later and another 100 miles further on, Mach 3 is exceeded.

The passengers are now sitting back comfortably, in their 2,000 knot armchairs, 14 miles high, enjoying the wide panorama of broken cloud and sunlit sea so far below, with the coast of Ireland like a map away to starboard, while the smiling stewardess brings round the second—but not the last—breakfast of the day.

There was a time when some, shortsighted, people frowned on the provision of windows for supersonic flying. How little they understood passenger psychology—or the superb quality of the views to be had as the aircraft moves smoothly along above almost all cloud at nearly 40 miles a minute.

Settled down into a steady cruise of 2,000 knots (M=3.5) "Supersonica" drones steadily on, its "sonic" boom cracking like thunder across the ocean—but all quietness and serenity inside the liquid-cooled cabin.

A leisurely breakfast takes just over an hour—and it is time to let down from 80,000 feet. Three hundred miles from New York—with landing clearance already obtained—"Supersonica" starts down, decelerating, with a vertical "fall rate" of more than a mile a minute. By the time the aeroplane is down to 40,000 feet it is subsonic again—and just two hours and ten minutes after take-off it is landing docilely at Idlewild.

The time is now 11.10 in London. But, in New York, five hours back, the clock stands at 6.10 a.m.

Through Customs and into the fast airport limousine—a turbine helicopter an alternative at a higher fare. Forty-five minutes after touch down our supersonic passengers are entering their hotels. It is 7 a.m.—and time for the third breakfast of this 29 hour day.

As for the aeroplane, by 8.15 a.m. New York time it is on its way back to London where it arrives at 3.30 p.m., six and a half hours after its departure for New York.

At Mach 3.5 a maximum of two flights in each direction a day can be achieved without subjecting passengers to "impossible hours"—no take-off before 8 a.m., no landings after midnight.

In fact, the schedules of one aeroplane can be:

Depart L.A.P.	1. 0900 hours GMT. 2. 1730 hours GMT.
Depart New York	1. 0815 NYT (1315 GMT) 2. 1630 NYT (2130 GMT)

This gives a reasonable utilization of eight hours forty minutes a day—at the rate of 3,160 hours a year.

As for the costs—yes, certainly they are higher than the subsonic types. But, even at premium fares the aircraft are full. And for those who do not object to spending five hours longer on the journey, there are always the "Loafair" services at half the price. They are full too.

In the old Fair Ground phrase—"You pays your money and you takes your choice".

Indeed, supersonics have made the Atlantic into a short-haul operation. Half way round the world is now only six hours flying time. Progress marches relentlessly on.

The next stage is passenger ballistics.

	1960 **Subsonic Jet**	1970 **"Supersonica"**	1970 **"Loafair"**
	(112 passenger seats)	(120 passenger seats)	(300 passenger seats)
Check-in to coach departure at city centre	15 mins.	10 mins.	10 mins.
To airport	Coach 45 mins.	Monorail 20 mins.	Monorail 20 mins.
Coach arrival to take-off	30 mins.	10 mins.	15 mins.
Aircraft ramp to ramp	**9 h 05 mins.**	**2 h 10 mins.**	**7 h 15 mins.**
Ramp to coach departure	45 mins.	20 mins.	35 mins.
To city centre	1 h 00 mins.	25 mins.	25 mins.
City centre to city centre	**12 h 20 mins.**	**3 h 35 mins.**	**9 h 00 mins.**
Mean speed between city centres	282 m.p.h.	972 m.p.h.	386 m.p.h.
Ramp to ramp speed	380 m.p.h.	1,580 m.p.h.	473 m.p.h.
Cruise speed	560 m.p.h.	2,300 m.p.h.	575 m.p.h.
Mach No. cruise	0.85	3.5	0.87

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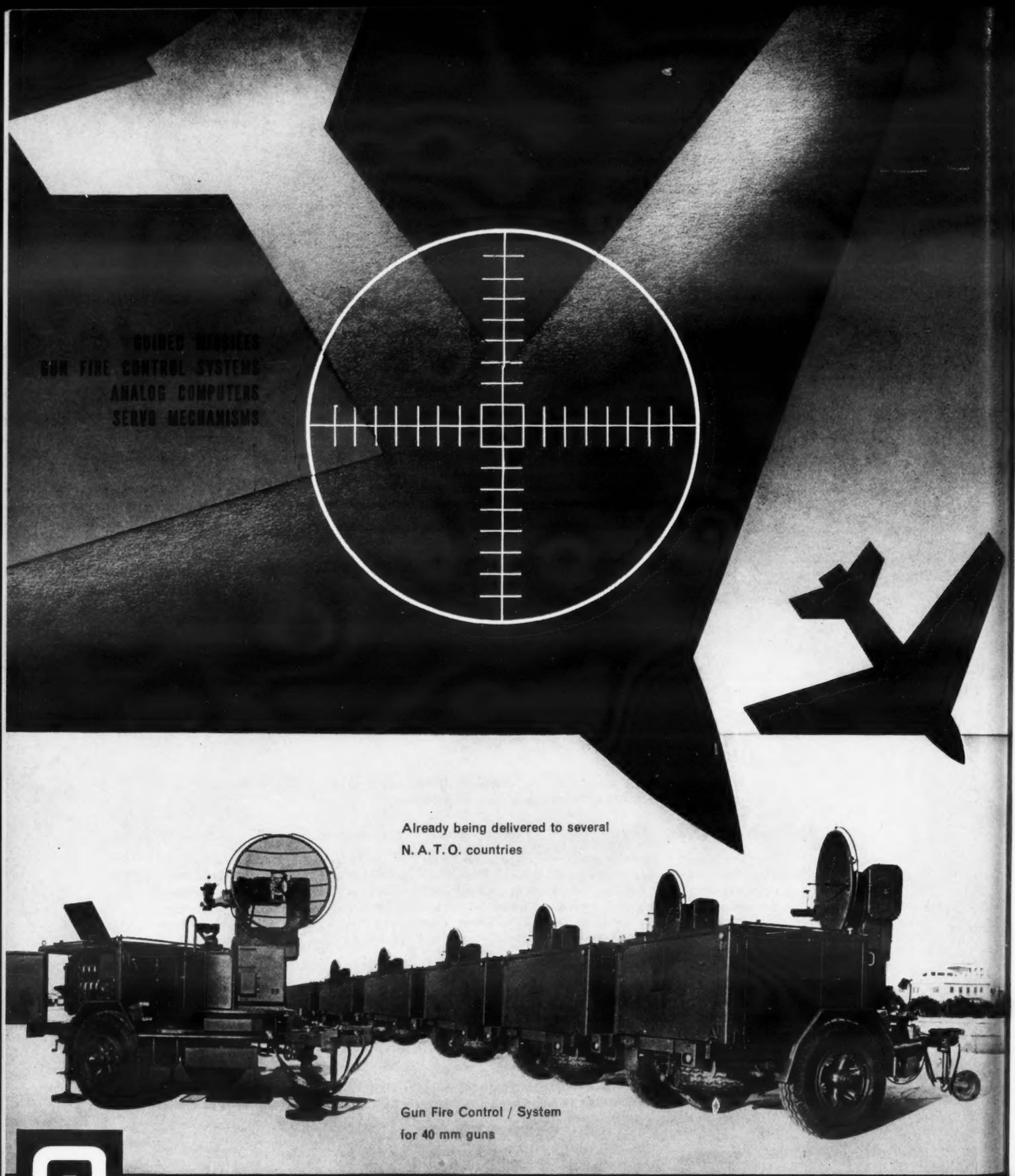

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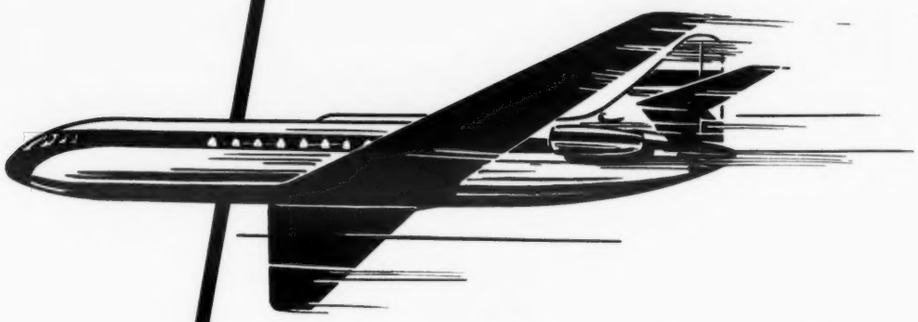

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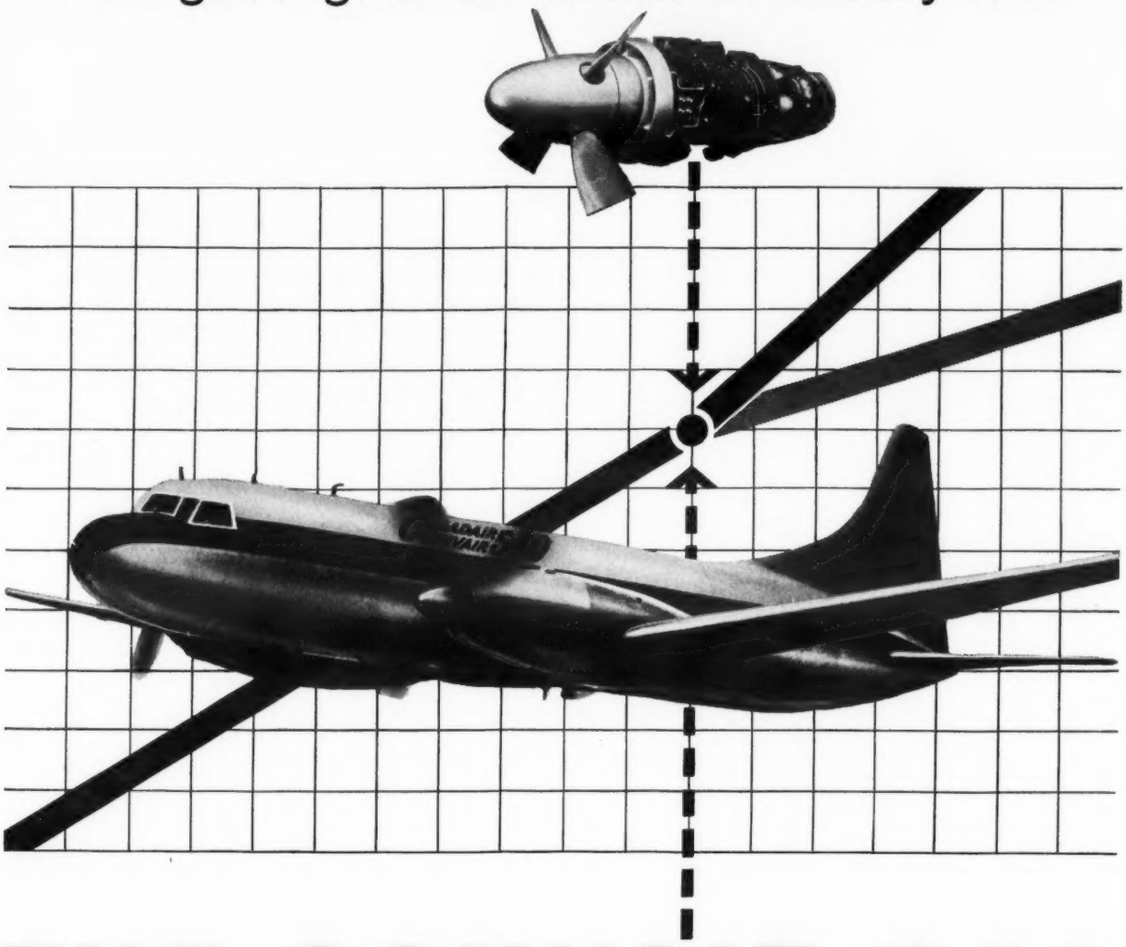

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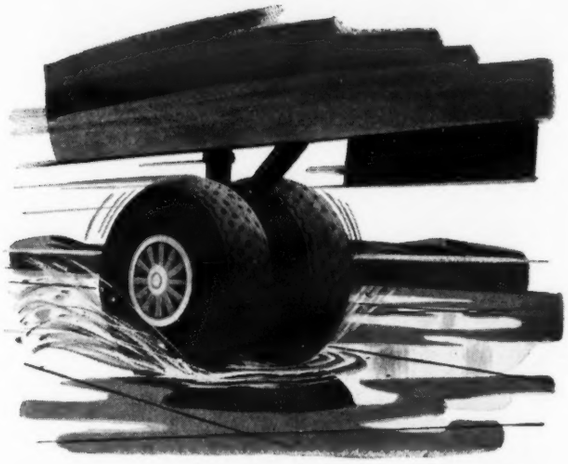

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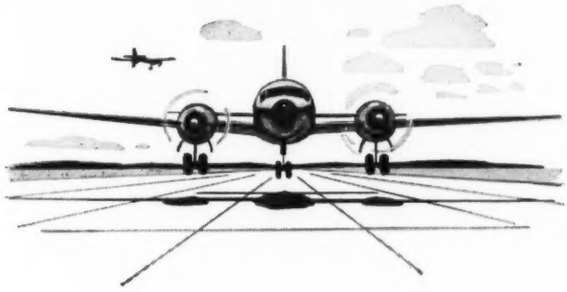

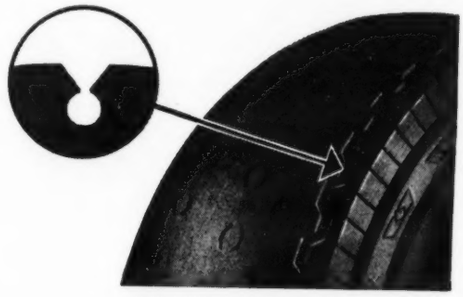

3 **ON SMOOTH, HOT RUNWAYS** Hi-Lander Tire provides efficient heat dissipation even at high landing speeds. Tire is an ideal choice for tandem-type bogie aircraft. Reason: tread will not peel when wheels are subjected to sharp turns. Remarkable strength of Hi-Lander comes from famous Goodyear *triple-tempered* nylon cord construction.

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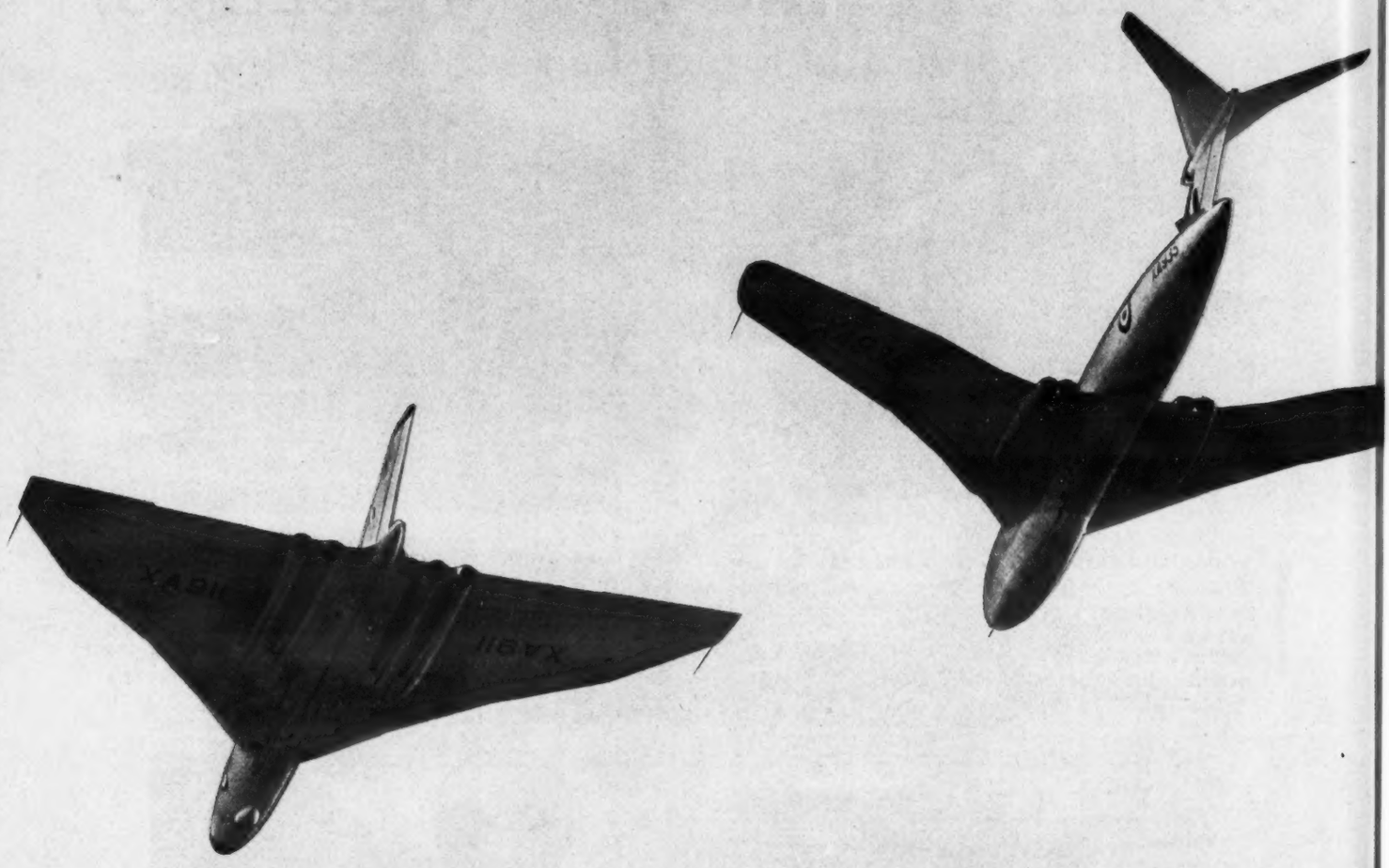

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Fares, Propellers and Jets

by Frank Robertson

The author, Chief Designer of Short Brothers & Harland's newly formed Light Aircraft Division, is widely known as a vigorous supporter of the turboprop aircraft and a stubborn opponent of the jet. In expressing his views on this controversial subject he pulls no punches, but his article is given in full below as a possible stimulus to further discussion. Editors.

A lot of important people are beginning to get excited about air fares. They are starting to have doubts about the " Golden Jet Age " which has been sold so well. They are starting to wonder who is going to get the gold—in fact, whether there is going to be any!

As a member of the select minority which has consistently opposed the big jets as a universal transport and whose predictions are now beginning to be supported by statistics, I welcome the opportunity to comment on the present scene and to air my views as to the future.

Let us first paint in the background. By 1945, Douglas, with some help by Boeing, Convair and Lockheed, had brought the piston engined propeller driven transport aeroplane to a pitch which made air transport begin to look like big business. Outside the USA, no-one had an aeroplane worth a damn in this class and no-one felt very keen on projecting one because the gas turbine engine had arrived.

On both sides of the Atlantic, engineers started feverish programmes of preliminary design and operating cost analysis in order to try to make up their minds which way to jump—whether to make the gas turbine drive a propeller or produce a jet. Those who took sufficient care with their sums got the right answer which should never be forgotten when air transport is being studied and which can be summarized by the following three " texts ":—

1. Minimum direct operating costs for piston engined transport aircraft intended for regular airline service are obtained when the aircraft is optimized to cruise at speeds between 150 and 250 knots and heights between 10,000 and 25,000 ft according to the design range. The longer the range, the greater the optimum speed and height. Size of aircraft also has an effect. Minimum costs are obtained with the largest aircraft the traffic will fill.

2. With turboprop power, optimum speed for minimum costs rises to between 275 and 400 knots and heights to between 20,000 and 37,000 ft. The same rules regarding range and size apply as before. The important points to remember are:—

(2.1) Operating costs can be as much as a third lower than with piston engines for the same size aircraft.

(2.2) Size for given payload and range remains much the same.

(2.3) Runway requirements and circuit speeds also remain much the same.

3. With turbojet power, optimum speed for minimum cost rises to between 400 and 500 knots and heights between 30,000 and 45,000 ft. Here the important points to remember are:—

(3.1) Operating costs can only be got down to piston engine aircraft levels in the very large sizes.

(3.2) Size for given payload and range is greater.

(3.3) Runway requirements are greater and circuit speeds are higher.

Faced with this position, it is interesting to look back at what the (then) two great potential powers in Civil Aviation, USA and U.K., did about it. Britain had no worthwhile civil aeroplanes, so she stopped work on piston engines and went all out for two types of turboprop—one short range and one long range—and one type of turbojet—medium range—recognizing the fact that there would always be some customers for the " fastest " but a large number of customers for the " cheapest ". The USA, sitting pretty in the knowledge that practically all the world airlines were flying American piston engined planes, decided there was time for another generation of these first and bided her time over turbines. Uncle Sam banked on his customers' reluctance to change their " shopkeeper " coupled with the belief that the first of a new kind of aeroplane would be unlikely to be a winner.

The *Comet*, the *Viscount* and the *Britannia* shook him to his very foundations; what could be done in time to prevent the British from taking over the lucrative markets which Douglas, Lockheed, Boeing and Convair had worked so hard and well to gain?

Government research groups, airline operational teams, manufacturers' preliminary design teams all did their optimization sums over and over again. Where was the break-through? The *Viscount* was obviously a winner. To beat it, they had to have an engine of about the power of the *Dart*, but with a much lower consumption. There wasn't even one on the drawing board—not even in Britain let alone the USA, so let it go. Concentrate on improving the Convairliner and *selling* it as only the USA knows how to sell. How well they succeeded can be judged by how few U.S. airlines did in fact buy *Viscounts*.

Then someone thought up the Great Jet Age plan. I often wonder who really was the genius behind it. Whoever he was, he saved the U.S. aircraft industry but put the possibility of flying for the man in the street out of reach for at least ten years. The bricks with which the glittering edifice was built can be enumerated as follows:—

1. The USA had military jet engines and aeroplanes which worked, but no turboprops.

2. The *Comet* suffered catastrophic structural failure.

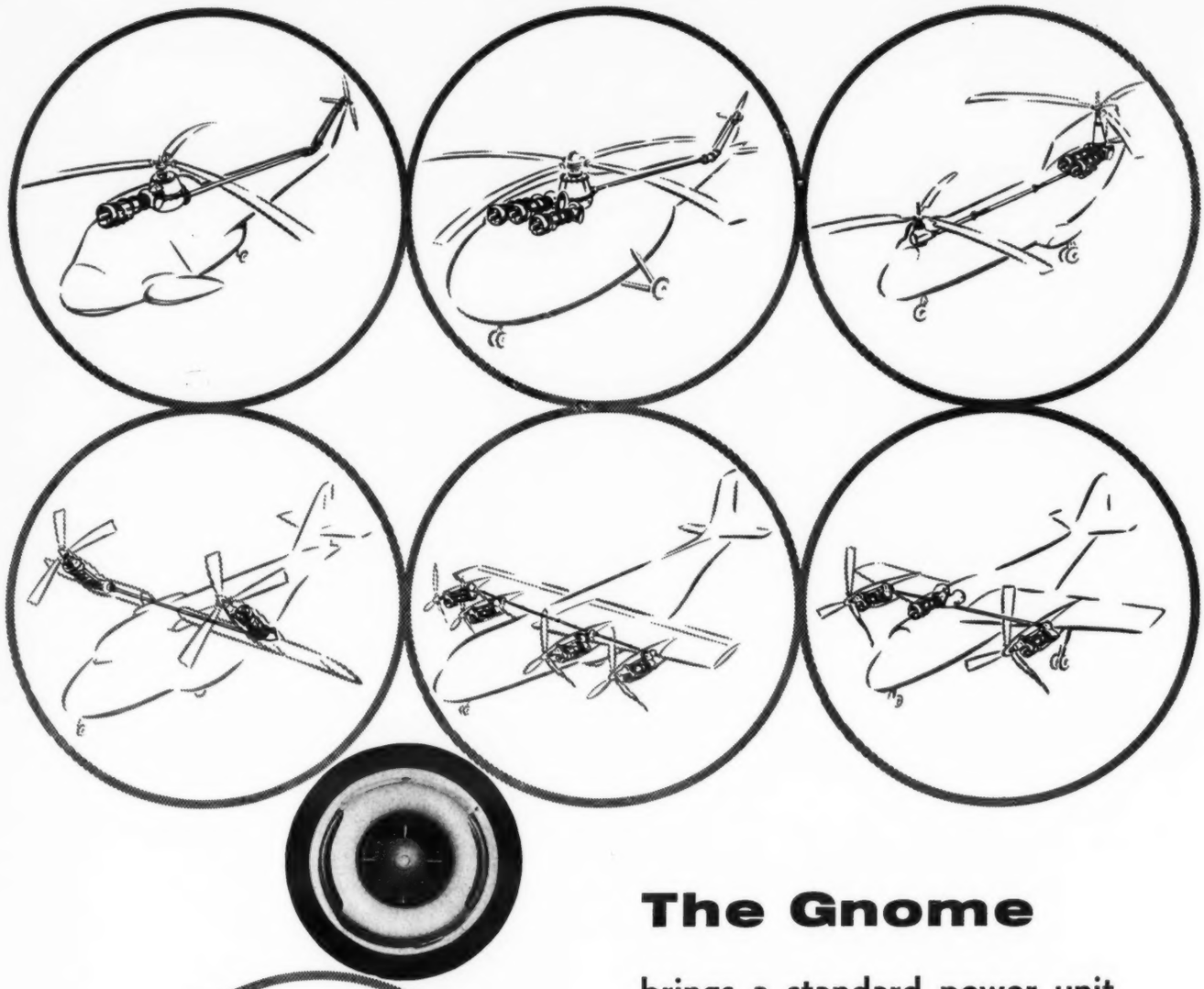
3. Optimization studies showed that the best speed for turbojet economy was at least 50 knots faster than the *Comet*.

4. The *Comet* was not a long enough range aircraft to operate economically on the North Atlantic.

5. The *Britannia* was so far behind schedule that BOAC had to buy more piston engined planes to fill the gap.

6. Optimization studies showed that the best speed for turboprop economy was at least 50 knots faster than the *Britannia*, particularly on the North Atlantic where a return trip in 24 hours was a critical feature.

7. Air traffic was growing steadily, and most airlines were ripe for ordering new equipment.



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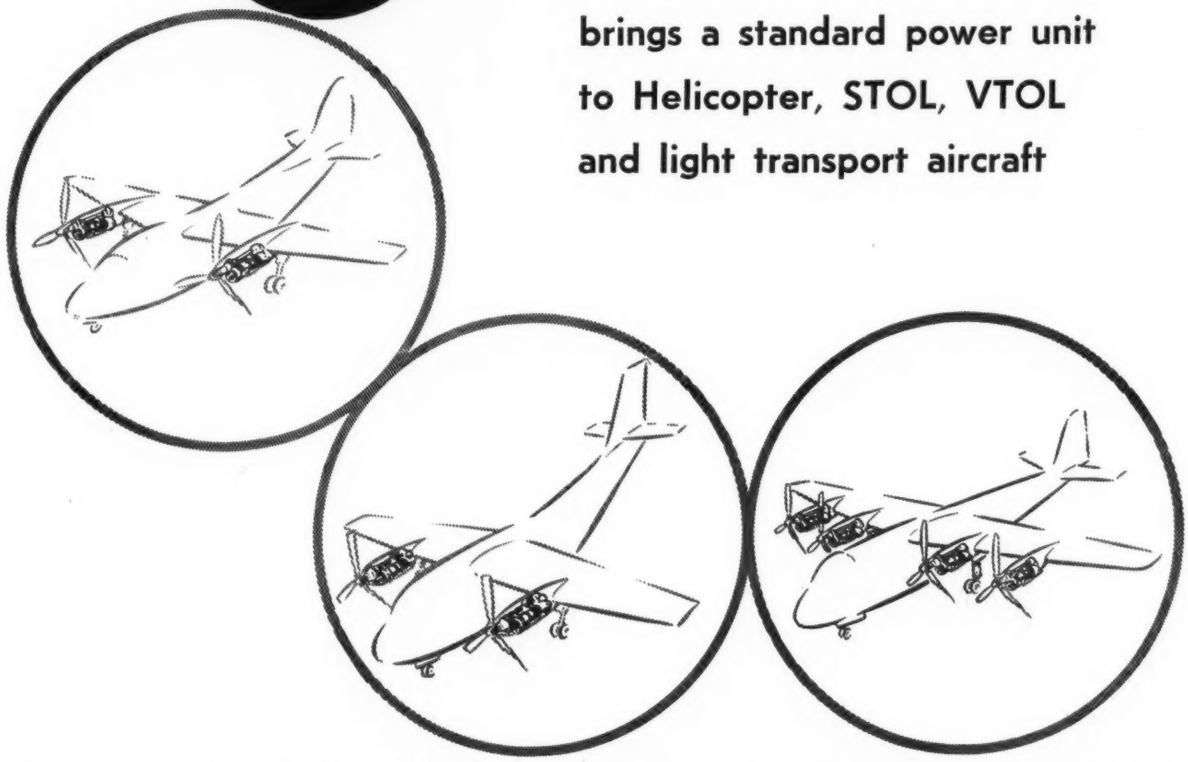

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8. Optimization studies showed that a jet aeroplane could be built (on paper) which would be as fast as anything which was likely to fly until supersonics became the order of the day and which would have operating costs no higher than existing piston engined equipment. It would, of course, be twice as big but the ever-increasing traffic would look after that!

Once the master plan was conceived, just see how the national interest was served. Government money poured into Boeing to get the jet tanker into the air. Douglas and Convair fell into line with designs which, to the man in the street, were indistinguishable from the Boeing. (" Look how alike all our new planes are, Daddy, our designers *must* be right. All those queer foreign firms keep producing aeroplanes which all look different! ") The biggest and best aircraft sales campaign in history was set into world-wide motion. Even serving officers were roped in (unofficially, old man, of course!) and at no time, to my knowledge, did the Americans ever claim that the turbojet was as cheap to operate as the turboprop. They were much too clever. All they claimed was a superiority over " existing equipment ".

Those airlines of the world which operate long ranges were faced with two alternatives. Buy *Britannia* and hope that IATA could be persuaded to allow reduced fares where aircraft operating costs made them feasible, or buy American, leave the fares alone and " keep up with the Jones's ". It is scarcely surprising that the majority took the line of least resistance; particularly since BOAC were early bidders for the Boeing and no-one in Britain seemed likely to make a really vigorous effort to go one better than the *Britannia* in the long range market. Even Bristol seemed to have lost faith in the ultimate economic superiority of the turboprop and were turning their attention to jets.

Thus we arrive at today's position. Stages up to about 1,000 miles are being operated by *Viscount*, Convair and *Dakota* at costs of about 5d. per seat mile, of which half represents aircraft operating cost and half comprises airline overheads. The long ranges are operated at costs of about 7½d. per seat mile by *Constellation*, DC-6, DC-7, *Stratocruiser*, *Britannia*, *Comet* and Boeing 707. The order books show that, whereas most of the short range operators show little sign of replacing *Viscount*, nearly all the long range boys have ordered Boeing or Douglas.

The speed of the big jets is making the short range operators fidgety because they fear that " overruns " on short distances by the big jets will attract a lot of their traffic. The result is that some operators, BEA for example, are stepping on to the jet wagon for short/medium ranges by buying *Comets* and even ordering a brand new aeroplane.

All over the world, operators and airfield owners have scraped the barrel to pay for jet aeroplanes whose traffic potential far exceeds the available market (at the price) and for larger and stronger runways to carry them. As I and others predicted, the jet aeroplanes are proving more costly to operate than the " glossy brochures " indicated, traffic has failed to rise to the required level, and now fares will have to go up in order to keep the operators in business.

What a tragedy it is that such a powerful weapon for world peace and common welfare as air transport should have allowed itself to get into such a state. The first act of the tragedy is over. The jets are here. It now remains to be seen whether the second act will reach its curtain before the promoters go broke! The second act, of course, is the advent of the supersonic transport. The politicians are already being jockeyed into the position where more vast sums of money will be spent to purchase sheer speed. The hungry seekers for technical prestige are already producing figures to show that supersonic transport will only be " a little dearer " than subsonic jet transport. The ground upon which these forecasts are being made is, of course, technically about as solid as the Goodwin Sands and the fact that subsonic jet transport has now been proved to be dearer than subsonic turboprop travel has been well and truly concealed.

In this madhouse atmosphere, the customer, as usual, is being entirely ignored. By the customer, I don't mean the Government Departments and airlines which buy the aeroplanes but the common traveller who buys his airline ticket and the common taxpayer who provides the hard cash which is spent in such a cavalier manner.

One gleam of hope emerges. The more " Alice in Wonderland " the air transport business in general becomes, the better the chance of ultimate success for the hard-headed manufacturer or operator who is determined never to build or operate a new aeroplane unless it is substantially cheaper to run than its predecessor.

We all know what everyone needs. The man in the streets wants cheaper fares. The airline operator wants more traffic. The aircraft manufacturer wants more orders. The solution is childishly simple; build aircraft with lower direct costs, pass this reduction straight on to the ticket buyer, watch the traffic rise and the overheads fall and then pass the drop in overheads also on to the ticket buyer. If only some intelligent and powerful country or group of countries would adopt and pursue this policy, world air transport would start to come into its own.

Being British, I should naturally like to see the British Commonwealth giving a lead in this matter.

Now just what does constitute the cheapest aeroplane to operate? The answer is not a simple one; in fact, no general answer can be given. For every stage and traffic density a different aeroplane is needed to give absolute minimum costs. Obviously such a vast number of different types cannot be contemplated, but certain significant stage lengths and traffic densities are becoming apparent as, indeed, they have at sea. Union Castle, for example, know what speed and size of ship they need for the South African run, and their requirements differ widely from Cunard's on the North Atlantic.

Probably the three most important passenger aeroplanes in the world are:—

1—the 500 mile 50-100 seater

2—the 1,500 mile 100-150 seater

3—the 4,000 mile 150-200 seater

These three are certainly sufficiently diverse to show whether a change of power plant is likely to be needed to achieve minimum costs. Time and time again, I have optimized hypothetical designs for these three types. Each time I have brought in the latest improvements in the state of the art in engine and airframe design. Every time I get the same answer. For given standards of thermal, aerodynamic and engineering efficiency, the turboprop is the cheapest form of travel over all stage lengths.

The *Viscount* certainly fits category No. 1, but where is its successor? With today's knowledge, surely we could have an engine of similar power to the *Dart* but having the specific fuel consumption of the *Tyne*. Surely, too, we could expect a small reduction in empty weight as a percentage of gross weight and an improved structure from a " life " aspect, coupled with aerodynamic improvements to give 50-knot higher cruising speed for the same power and stalling speed. Such an aircraft would produce operating costs at least 30% lower than the *Viscount*.

The *Vanguard* almost fits category No. 2, but I do believe that it ought to have two alternative fuselages —one for capacity payload in passengers and one with rear end loading, for capacity payload in freight. As it stands, it seems to me to need a full load of passengers and freight to reach its minimum operating costs, and I do not believe that freight and passengers should be mixed.

What about category No. 3? This is the one which really burns me up. With the *Tyne* engine we could have a Transatlantic aeroplane which would carry the same payload as the Boeing 707 or Douglas DC-8 out of not much more than two-thirds of the runway length. It would weigh 200,000 lb instead of 300,000 lb, and at 400 knots its crossing time would be 7 hours against 6 hours for the big jet. Direct operating costs would be between 25 and 30% less.

Everything I have written so far refers to passenger traffic; freight traffic presents a different problem. With passengers, fare reductions bring increased traffic along a fairly smooth curve as lower and lower income brackets are penetrated. With freight, a fare reduction below a certain level will suddenly bring in another commodity which may have totally different density and geometrical characteristics from anything which has previously been carried. Another important factor is the ability of passengers to walk out of the aeroplane! Freight has to be carried.

Generally speaking, therefore, freight aeroplanes must be bigger in hold capacity for a given payload and must have large doors to facilitate loading and unloading. These requirements result in the freight aircraft having a lower cruising speed for optimum cost than has the passenger aircraft, a fact which makes the turboprop an even more definite choice for the freighter than for the passenger aircraft.

Summing up, I believe that the passenger is being " taken for a ride " today by the introduction of the wrong kind of aircraft for his needs. I believe that this state of affairs has been brought about entirely by the U.S. aircraft industry in their efforts to prevent the British industry from stealing a march on them with turboprops. I believe that the U.S. industry has succeeded in its mission and that we shall now see a gradual introduction of the right kind of aeroplanes. USA and USSR, too, now know how to make turboprops, and U.K. has lost the finest chance it ever had of gaining a firm place in the world as a civil aircraft manufacturer.

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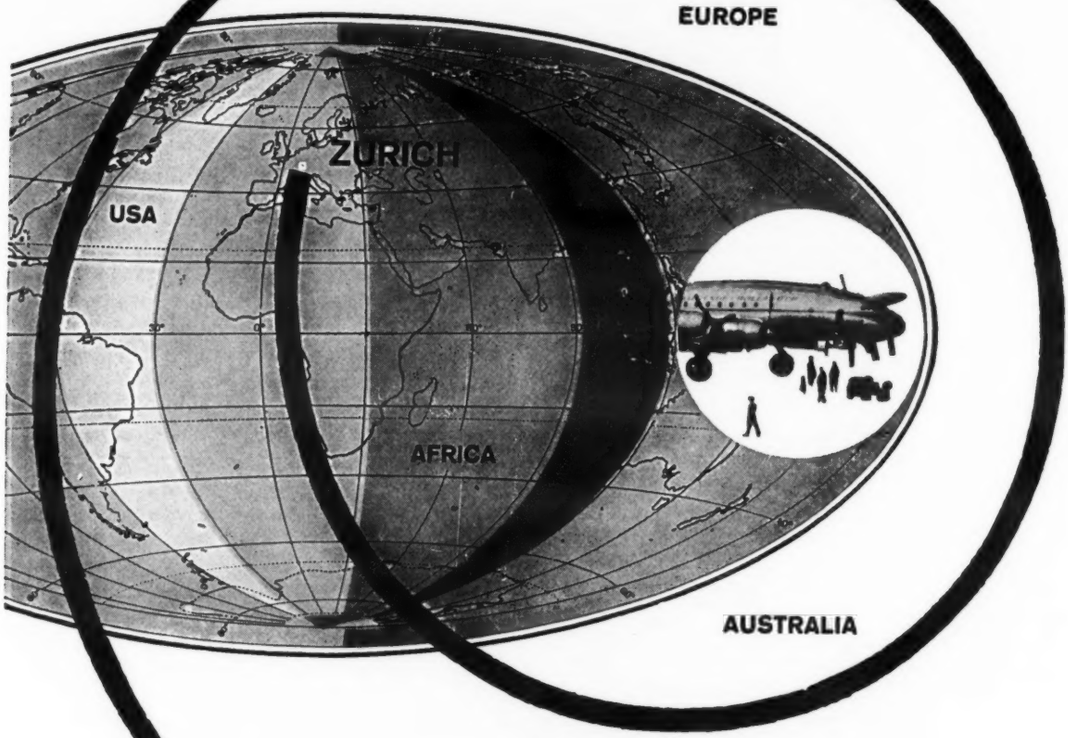

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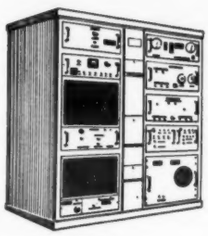

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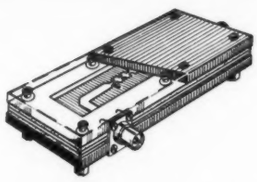

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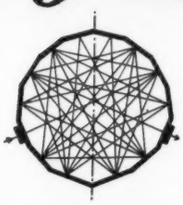

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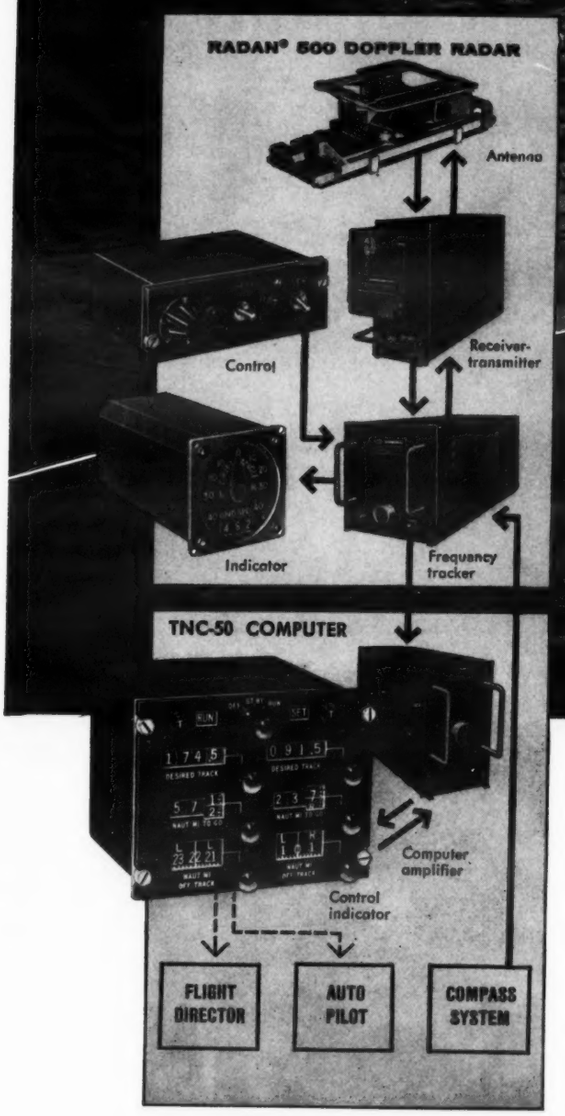

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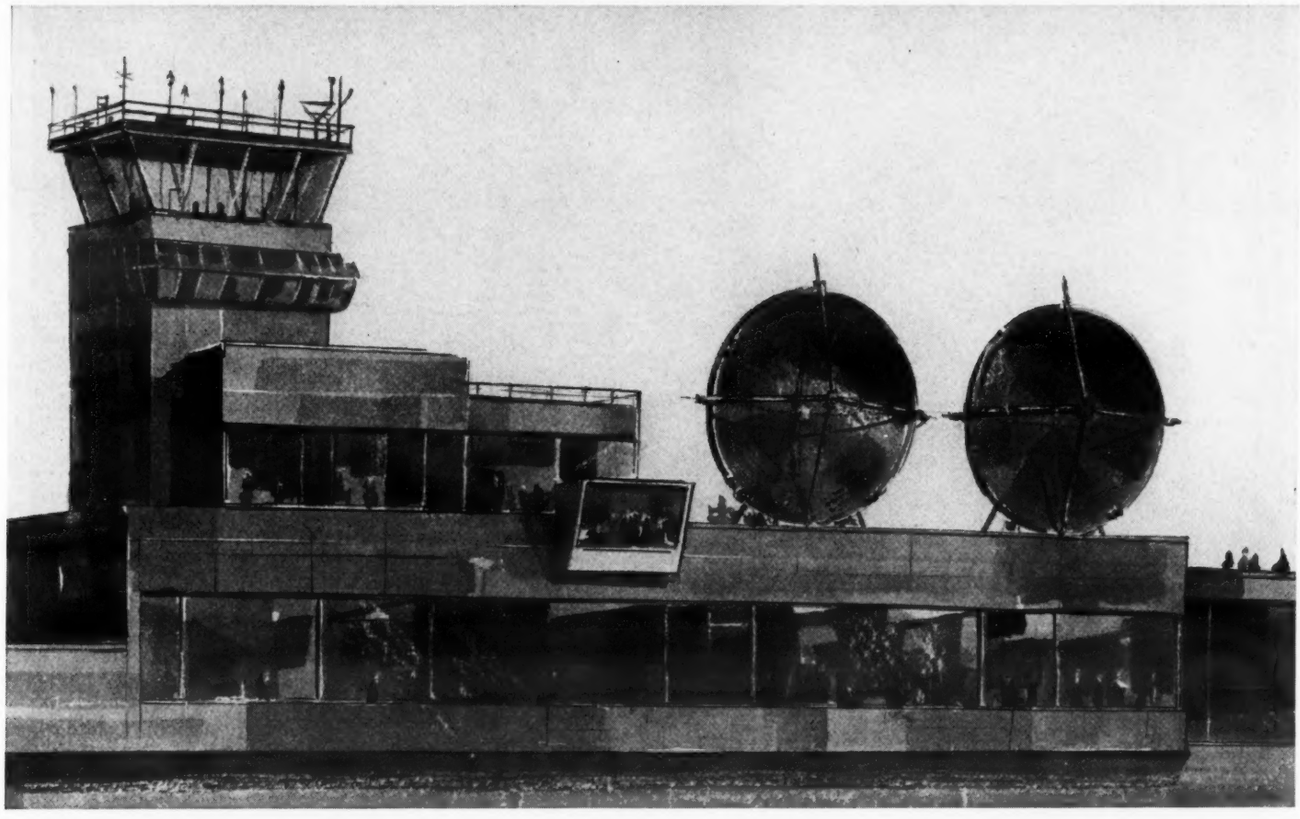

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Britain's "Mixed Economy" in Air Transport

by Stephen Wheatcroft, London

Seven years have passed since the British Government issued the Air Transport Advisory Council with new terms of reference designed "to give greater opportunities to private enterprise to take part in air transport development, without in any way impairing the competitive strength of our international air services". Opinions differ whether these have been fat or lean years for the independent airlines. In view of recent statements by the Minister of Transport and Civil Aviation that he is considering a revision of the present licensing system, it may be opportune to review the broad changes in the shape of British air transport which have taken place since 1952.

There can be little doubt that significant changes have occurred in the past seven years. The independent airlines have increased their share of total British air traffic—in terms of passenger-miles—from 12 percent in 1951/52 to 32 percent in 1957/58. These figures include trooping and other non-scheduled operations, which still constitute the major part of independent airlines' traffic. In the field of scheduled services the independent airlines have increased from an insignificant 1 percent of the total in 1951/52 to just over 11 percent in 1958/59.

Writing about a subject so close to the political arena as air transport has been, it is difficult to avoid questions which are not strictly economic. One of the major changes in British air transport in the past seven years is the lessening of the political controversy which has bedevilled its progress for three decades. This is not to say that there are no political issues at the present time but there is, in my judgment, more general political agreement about the broad framework of the industry than at any time since 1919. What I have in mind is the bi-partisan acceptance of the fact that the "mixed economy" has come to stay: both major parties agree that the publicly owned and privately owned sectors of the industry have an important part to play in its development. Labour members may still speak in the House of Commons as defenders of the Air Corporations, and Conservative members regularly appear in the role of champions of private enterprise airlines. But as far back as 1948 it was a Labour administration which first accepted the authorization of independent airlines as "associates" of BEA. And since 1952 Conservative ministers have honoured their pledge that they would not allow the operations of the State Corporations to be undermined. The political argument is now about shares of traffic and not about sole ownership.

Traffic Statistics

Detailed figures of the changes in shares of British air traffic carried by the Corporations and the independent airlines are set out in *Table 1*.

One of the most interesting features of this table is the way in which BOAC's share of the total and scheduled traffic has fallen, as the independents' share has risen. This might easily lead to some erroneous conclusions about traffic diversion, for the main weight of independent airlines' expansion of scheduled service sand inclusive tours has been in the sphere of BEA's operations rather than BOAC's. A material factor influencing BOAC's share of British air traffic recorded in Table 1 was the setback which it sustained in 1954. BOAC lost a great deal of ground in its relative position in the world airlines industry as a result of the *Comet* disasters, and it is doubtful whether, even now, it has fully recovered the share of world traffic which it might otherwise have enjoyed.

In *Table 2* a breakdown is given of independent airline traffic in four categories. The first two are scheduled operations sub-divided between inclusive tours and normal scheduled services. The last two are non-scheduled services divided between civil and military. It will be seen that although non-scheduled operations have become relatively less important over the past few years, they still represented 75 percent of independent airlines traffic in 1957/58, and trooping alone still accounted for almost two thirds of the total passenger-miles.

Nevertheless, inclusive tours and other scheduled services have clearly been the fastest growing sectors of independent airlines traffic during the past seven years. It would be interesting to have more detailed information about the composition of scheduled traffic, but unfortunately the figures published by the Air Transport Advisory Council in their annual reports give only passenger numbers, not passenger-miles, for the significant subdivisions of this traffic. It is possible, however, to estimate from published data a reasonably reliable breakdown of traffic carried on independent scheduled services. Such an estimate for 1957/58 is presented in *Table 3*.

Stephen Wheatcroft, who had served as a pilot in the Fleet Air Arm during the war, joined British European Airways in 1946, where he remained until 1953 as manager in charge of tariffs and commercial research. He then went to Manchester University for a year as a Simon Research Fellow and wrote "The Economics of European Air Transport", which was published in 1956 and brought him widespread recognition. Since 1954 he has practised as an air transport consultant and is retained by BEA as Economic Adviser.

The author stresses that the following article expresses his own personal views, which do not necessarily reflect those of BEA.

Editors.

The independent airlines

There are about 24 airlines in the private sector of the British air transport industry, and 18 of these are members of the British Independent Air Transport Association. There has been a marked tendency to concentration in recent years as a result of grouping of firms and by the rapid growth of the strongest operators. This tendency

TABLE 1

BRITISH AIR TRAFFIC

1951/52—1958/59

(Passenger-miles in thousands)

	SCHEDULED SERVICES (including Inclusive Tours)			ALL OPERATIONS		
	BEA [1]	BOAC	INDEPENDENTS	BEA	BOAC	INDEPENDENTS [2]
1951/52 [3]	309 287 (28 %)	772 998 (71 %)	14 598 (1 %)	309 287 (25%)	797 082 (63 %)	154 021 (12 %)
1952/53	372 966 (29 %)	879 829 (68 %)	35 224 (3 %)	372 966 (24 %)	914 883 (59 %)	264 455 (17 %)
1953/54	480 065 (33 %)	911 905 (62 %)	72 526 (5 %)	480 065 (25 %)	968 815 (51 %)	466 028 (24 %)
1954/55	577 078 (37 %)	874 454 (56 %)	113 368 (7 %)	577 078 (28 %)	905 740 (44 %)	591 423 (28 %)
1955/56	708 769 (37 %)	1 046 415 (55 %)	158 481 (8 %)	708 769 (27 %)	1 096 640 (42 %)	808 074 (31 %)
1956/57	808 872 (36 %)	1 200 322 (54 %)	230 252 (10 %)	808 872 (27 %)	1 254 744 (43 %)	890 598 (30 %)
1957/58	935 756 (37 %)	1 326 047 (52 %)	276 341 (11 %)	935 756 (27 %)	1 417 686 (41 %)	1 117 886 (32 %)
1958/59	988 329 (36 %)	1 459 993 (53 %)	309 061 [4] (11 %)	988 329 —	1 558 495 —	N/A —

Notes:

[1] BEA's non-scheduled operations are less than half of one per cent of total and are not separately reported.

[2] Independents' non-scheduled figures are available only for members of BIATA. These figures probably understate total by about 5%.

[3] BEA and BOAC figures are for year ending March 31st; Independents' figures are for year ending June 30th.

[4] 12 months ending April 30th, 1959.

has been accentuated by the need to find new capital for re-equipment with competitive aircraft. The private sector is now dominated by a small number of airlines, or groups of airlines, with five companies carrying about 90 percent of total independent airlines traffic. These five biggest private firms are:

Airwork (including Air Charter and Transair)
British Aviation Services (including Silver City and Britavia)
Eagle
Hunting Clan
Skyways

The activities of nearly all of these airlines are fairly well spread in the air transport field, though Hunting Clan, Eagle and Airwork have predominated in trooping activity, and the major part of Colonial Coach traffic has been carried by Hunting Clan and Airwork. In the two other fields important for independent airlines, freight services and vehicle ferries, Hunting Clan is the largest operator in the first, and Silver City and Air Charter predominate in the latter.

Although new and smaller firms may be relatively important in particular spheres, such as inclusive tours, none seems likely to challenge the five major independents for leadership in the private sector. Indeed, it seems much more likely that the tendency to concentration will continue.

Comparatively little is published about the profitability of the independent airlines, partly because the financial results of so many of them are consolidated in the accounts of parent companies. It is one of the significant developments of recent years that these parent companies are now largely controlled by shipping firms: four of the five major independent airlines listed above now depend mainly on capital from shipping interests. It is to be hoped that any new system of economic regulation of British air transport will include more comprehensive requirements for the reporting and publication of financial and statistical information about independent airlines operations.

Low fare services

There are two areas in which the struggle for larger shares of British air traffic is concentrated at the present time: low fare services to the Colonies and cheap inclusive tour operations. The first is primarily a fight with BOAC and the latter almost exclusively concerns BEA. Both Corporations are aware that the future distribution of British air traffic depends upon their abilities to compete with the private airlines in the lowest price travel markets.

TABLE 3

Estimated percentage distribution of passenger-miles carried by independent airlines in scheduled services in 1957/58

	Percentage
Inclusive tours	35
Colonial Coach and Coach	25
Other international scheduled services	22
U. K. internal services	18
	100

The decisions which the Government makes on applications by Eagle, Hunting Clan and Airwork for low fare services to the Colonies may have far-reaching effects on the future pattern of British air transport, because the fare levels proposed cannot fail to have major repercussions on the whole international fare structure. But no useful purpose is likely to be served by speculation on the outcome of the deliberations now going on in the Ministry of Transport and Civil Aviation.

The other major area of conflict between the public and private sectors of the industry is the inclusive tour market. This has been the most rapidly growing sector of independent traffic in the past five years, and an increase of almost fifteen-fold has been recorded. Moreover, this traffic showed an increase of 25 percent last year at a time when BEA's passenger-miles increased by less than 6 percent. Inclusive tour operations are still only a relatively small part of total British air operations. But, because they are concentrated in limited markets, inclusive tour operations have assumed an importance in air competition greater than their absolute size would suggest. On certain important routes inclusive tour operators now carry the major share of air passenger traffic. BEA's Report for 1958/59 gives details of some of these, and routes to Spain are an outstanding example. " Charter and I.T. traffic carried by British independents to eastern Spain increased by 31 percent in the summer (1958) and was almost twice as large as the total traffic carried on scheduled services by BEA and Iberia between the United Kingdom and Spain."

Future policy

The purpose of this article has been to present a short factual survey of the changes that have been taking place in the structure of the British air transport industry in the past few years. I am not concerned to offer a personal opinion whether these changes are to be regarded as a good thing or a bad thing. But I have suggested earlier that there is a large measure of bi-partisan agreement that the air transport industry should continue to develop on a mixed economy basis, the differences in party attitudes being matters of emphasis rather than basic policy. If a Conservative Government is returned to office at the forthcoming General Election the independent airlines may reasonably expect to expand more rapidly than they would under a Labour Government. But there can be little doubt that even under a Labour Government the independent airlines will still continue to enjoy a significant share of British air traffic. If this premise is accepted it seems reasonable that both parties should also agree on some of the conditions which are necessary to make the mixed economy work satisfactorily. I am not thinking of the major issues of future policy such as the criteria to be used in demanding new licences or the " grandfather " rights to be accorded to established operators. The following points illustrate the sort of conditions which I think might be accepted as common ground.

The most important point is the unequal obligations of the public and private airlines. It was gratifying that the recent report from the Select Committee on Nationalised Industries (HMSO—May14th,1959) gave prominence to this question. The whole report illustrates the extent to which party politics are disappearing from air transport policy and it presented a bi-partisan view that the Corporations should be specially compensated for any non-commercial obligations placed upon them. Particularly important in this field are the heavy costs associated with the development and introduction of new British aircraft. The Select Committee concluded that these costs fall too heavily on the Corporations and place them at a disadvantage with their competitors. Similar conclusions were reached about the obligations of the Corporations to provide non-commercial services (e.g. BEA's Scottish services) or to make non-commercial investments (e.g. BOAC's participation in Kuwait Airways).

A second subject on which general agreement ought to be possible is the need for a more comprehensive and more purposeful system of licensing than the present rather ad hoc arrangements. It is desirable, in my view, that the licensing authority should be able to give more consideration to the economic consequences of its decisions than the ATAC can do under the 1952 terms of reference. It is difficult to believe that the proliferation of low traffic density routes which have been authorised since 1952 has been in the best long-term interest of British air transport development.

A final point is that effective economic regulation is not possible unless fully adequate financial and statistical data are published for all operations. This was recognised by the Americans when the Civil Aeronautics Board was set up in 1938. It is not enough that the authorities should think that they have adequate private information. All parties in any licence application ought to be able to test fully the validity of claims made by others. A serious weakness of the recent hearings on applications by independents for low fare services to the Colonies was this economic aspect. The financial soundness of the fare levels proposed was not adequately proved, but neither could it be effectively challenged.

The foregoing three points of future policy do not represent an exhaustive examination of the problems of making the mixed economy work. But if there is, as I believe, general agreement that the mixed economy has come to stay in British air transport, then thought and action along the lines discussed is clearly necessary.

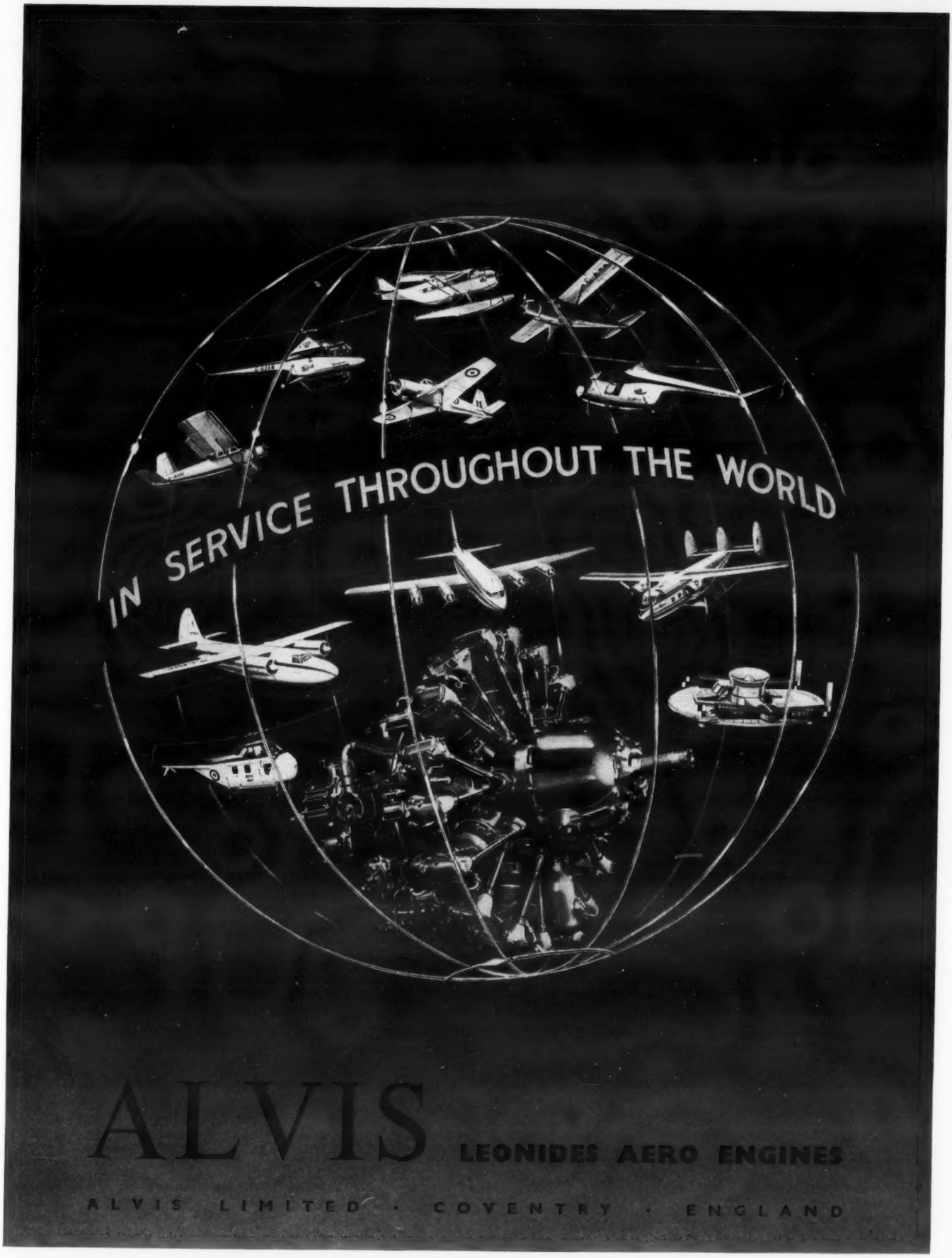
TABLE 2

DISTRIBUTION OF TRAFFIC CARRIED BY BRITISH INDEPENDENT AIRLINES

(Passenger-miles in thousands)

	SCHEDULED		NON-SCHEDULED [1]	
	Inclusive Tours	Others	Civil	Military
1951/52	— 0	14 598 9 %	30 303 20 %	109 120 71 %
1952/53	— 0	35 224 13 %	36 731 14 %	192 500 73 %
1953/54	8 257 2 %	64 269 14 %	77 895 17 %	315 607 67 %
1954/55	18 188 3 %	95 180 16 %	90 509 15%	387 546 66%
1955/56	30 581 4 %	127 900 16 %	126 690 16 %	522 903 64 %
1956/57	67 021 8 %	163 231 18 %	144 044 16%	516 302 58%
1957/58	97 362 9 %	178 979 16 %	112 274 10%	729 271 65 %
1958/59	121 484 —	187 577 —	— —	— —

[1] See note 2 to Table 1.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CJ-805 Reliability—Throughout thousands of hours of "squawk-free" operation, CJ-805s are showing their ability to meet pilot requirements—in timely starting, fast full power for take-off, prompt response to throttle changes during landing approach and reverse thrust operation.

CJ-805 Response—In an emergency aircraft "wave off" during landing, CJ-805s are less than three seconds away from full power. From ground idle to take-off throttle settings the engine produces full power in less than 6 seconds. Throttle bursts, chops, in-flight shutdowns and restarts have been consistently accomplished without difficulty in the Convair 880s, G.E.'s leased B-66 and XF4D to extreme altitudes.

CJ-805 Maturity—CJ-805 production engines, identical to those flying on CV-880s, have already demonstrated ruggedness and maturity in thousands of flight and factory test hours. Two engines have completed 2000-hour ground tests—one of these is now flying in G.E.'s leased B-66, approaching 3000 hours total time. Pilots flying CJ-805 powered aircraft will have an engine whose design and operating maturity have been fully proven.

From the pilot's viewpoint, or any other, CJ-805 power makes good sense. For more information, contact your G-E Aviation and Defense Industries sales representative or *General Electric Company, Cincinnati 15, Ohio.*

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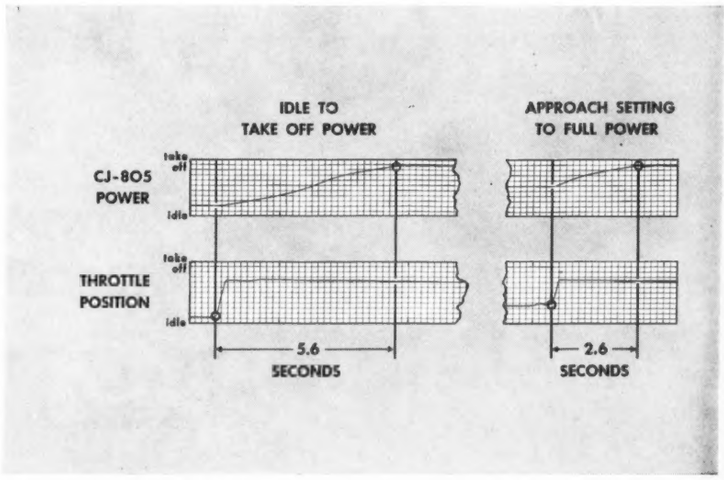
CONVAIR FLIGHT TEST PILOTS flying 880 evaluations are Don Germeraad (left) and Phil Prophett. Observed Germeraad, ". . . The G-E CJ-805 proved to me that it has power when you need it." From their point of view, the CJ-805 is a pilot's engine.



FAST RESPONSE TO THROTTLE takes CJ-805 fan engine from idle to take-off power in 5.6 seconds and from approach settings (20% power) to full power in 2.6 seconds. Brush tracings of an actual CJ-805 run document immediate, dependable response.

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GROUND COMMUNICATIONS EQUIPMENT

	Type Number	Power Output	Frequency Range (Mc/s)	Channels	Type of Transmission	Additional Features
UHF TRANSMITTERS						
Elliott	ERL 1	4W.	230-399	1 of 10	AM	—
	ERL 2	15W.	230-399	1 of 10	AM	—
G.E.C.	BRT 700	5-7W.	470	1	AM	—
Plessey	T. 7096	15-20W.	255-399.9	1 of 12	AM	—
	A. 7349 (Amplifier)	140-180W.	225-399.9	1 of 12	AM	—
	T. 7355	15-20W.	225-399.9	1	AM	—
	A. 9365 (Amplifier)	140-180W.	225-399.9	1	AM	—
Pye Telecommunications	PTC 3820	5	450-470	1	FM Simplex or Duplex	—
UHF RECEIVERS						
Elliott	ERL	—	230-399	1 of 10	AM	—
G.E.C.	BRT 750	—	470	1	AM	—
Plessey	R. 7351	—	225-399.9	1	AM	—
	R. 7109	—	225-399.9	1 of 12	AM	—
Pye Telecommunications	PTC 3810	—	450-470	1	FM	—
Stratton	Eddystone 770S	—	500-1000	—	AM ; FM & Pulse	—
VHF TRANSMITTERS						
B.C.C.	301	50 W.	30-174	1 of 3	AM	—
	311	15 W.	30-174	1 of 5	AM	—
	400	15 W.	30-174	1 of 6	AM	—
	405	20 W.	30-174	1 of 6	FM	—
Ekco	CE 91	15 W.	100-156	1	AM	—
G.E.C.	BRT 101	100 W.	70-180	1	AM	—
Marconi	AD 811	10-15 W.	100-156	1	AM	—
	AD 801	40-50 W.	100-156	1	AM	—
Pye Telecommunications	PTC 3600	1 kW.	118-136	1	AM	—
	PTC 351/352	50 W.	33-185	1 of up to 6	AM (wide band)	—
	PTC 353/354	50 W.	33-184	1 of up to 6	AM (narrow band)	—
	PTC 3301/3302	20 W.	25-174	1 of up to 6	AM	—
	PTC 3831/3832	20 W.	25-174	1 of up to 6	FM	—
Redifon	G 329	50 W.	72-177 (Restricted bands)	1	AM	—
S.T.C.	DU 5	50 W.	100-156	1	AM	—
VHF RECEIVERS						
B.C.C.	201	—	30-174	1 of 5	AM	—
	100	—	30-174	1 of 6	AM	—
	105	—	30-174	1 of 6	FM	—
Ekco	CE 6	—	100-156	1	AM	—
G.E.C.	BRT 195	—	70-180	1	AM	—
Marconi	AD 818	—	100-156	1	AM	—
Pye Telecommunications	PTC 3001/3002	—	25-174	1	AM	—
	PTC 3801/3802	—	25-174	1	FM	—
	PTC 3012	—	100-156	1	AM	—
	PTC 145	—	118-136	1 of 4	AM	—
Redifon	R 331	—	72-175 (Restricted bands)	1	AM	—
S.T.C.	RX 20	—	100-156	1	AM	—
Stratton	Eddystone 770U	—	150-500	—	AM ; FM	—
	770R	—	19-165	—	AM ; FM	—
	930	—	50-130 (Restricted bands)	—	AM ; FM	—
HF TRANSMITTERS						
G.E.C.	BRT 455	120-150 W.	2-16	2	Ao; A1; A2; A3	—
Marconi	HS 31	3½ kW P.E.P. 3 kW CW	4-27.5	1 of 6	A1; A3; A3b; F1; F4; F6	—
	HS 113	1 kW P.E.P/CW	2-24	1 of 4	A1; A2; A3; A3a; A3b; F1; F4; F6	—
	HS 22	250-350 W. P.E.P. 200-300 CW.	2-20	1 of 4	A3a; A3b; F2	—
	HS 92	400-500 W.	2-20	1 of 4	F1	—
Mullard	SL. 25	2 kW.	1.5-30	2 of 4	A1; F1	—
	GFT. 560 Series	2-3 kW. 1 kW. P.E.P.	1.5-30	Various combinations	A1; A2; A3; A3a ; A3b; F1	—
	SL.18	50 W.	1.5-12.5	1 of 8	A1; A2; A3;	—
	SL.57	50 W. P.E.P.	2-16	1 of 4	A1; A3; A3a	—
Pye Telecommunications	PTC 3630/3631	1 kW.	2-20	1	A3; A1; F1	—
	PTC 931	60 W.	1.6-14.0	1 of 4	A1; A2; A3	—
Racal	TA. 83	500 W. P.E.P.	3-15	1 of 4	A2a; A3; A3a	—
	TA. 104	60 W. P.E.P.	3-15	1 of 4	A2a; A3; A3a	—
Redifon	G 67	2-2.5 kW.	2-23	up to 4	A1; A2; A3; F1; F6	—
	G 420	1,5 kW.	1.5-30	up to 8	A1; A2; A3; A3a; A3b; F1; F6	—
	G 143	1 kW.	2-26	1 of 10 (auto-tune)	A1;A2; A3	—
	G 40	500-750 W.	2-25	1 or 2	A1; A2; A3; F1; F6	—
	G 77	150-200W.	1.5-24	1	A1; A3; F1; F6	—
	G 61	50 W.	2-10	1 of 5	A1; A3	—
S.T.C.	DS9C/DS29	600 W. P.E.P. 450 W. F.S.K.	2.5-22	1 frequency (tunable)	A1; A3; A3a; A3b; F1; F6	—
	DS12	2.5-4 kW. nominal	2.5-22 or 4-28	Tunable Various combinations	A1; A3; A3a; A3b; F1; F6	—

	Type Number	Power Output	Frequency Range (Mc/s)	Channels	Type of Transmission	Additional Features
HF RECEIVERS						
Airmec	C. 864	—	.015-.045 & .1-30	Tunable	A1; A2; A3	—
G.E.C.	BRT 400	—	.015-30	Tunable (6)	Ao; A1; A2; A3	—
Marconi	HR 11	—	3-27.5	1 of 6	A1; F1; F4; F6	—
	HR 24	—	3-27.5	1 of 6	A3a; F9	—
	HR 21	—	3-27.5	1 of 6	A3a; A3b; F9	—
	HR 51	—	3-27.5	1 of 3	A1; A2; A3; F1	—
	HR 54	—	2-27.5	1 of 5	A1; A2; A3	—
Mullard	GFR. 552	—	4-30	Tunable (9)	A3; A3a; A3b	—
	SL. 58	—	2-16	1 of 4	A1; A3; A3a	—
Plessey	PR 51 Series	—	2-30	1	A1; A3; A4	—
	PR 53 Series	—	2-30	1	A1; A4; F1	—
	PF 130 Pre-Selector	—	2-30	1 of 5	A1; A3; F1; F4	—
Racal	RA 17	—	1-30 (to .0125) *	Tunable	Ao; A1; A3 (A3a) * (A3b) * (A9) * (F1) *	—
	RA 87	—	3-15	1 of 4	A2a; A3; A3a	—
Redifon	R. 50M	—	.0135-32	Tunable	A1; A2; A3 (F1; F6) *	—
	R. 146	—	.25-24	Tunable	A1; A2; A3	—
	R. 150	—	.585-32	Tunable	A1; A2; A3 (F1; F6) *	—
	R. 145	—	2-30 (to .0135) *	Tunable	A1; A2; A3 (A3a; A3b) * (F1; F6) *	—
	R. 186	—	.0135-8	Tunable	A1; A2; A3 (F1; F6) *	—
	R. 93	—	2-20	1	A1; A2; A3 (A3a; A3b) * (F1; F6) *	—
	R. 151	—	2-27.5	1 of 6	A1; A2; A3; (A3a; A3b;) * (F1; F6) *	—
	R. 304	—	2-10	1 of 5	A1; A2; A3	—
	R. 401 * With adaptor	—	2-10	1 of 4	A1; A2; A3; A3a	—
S.T.C.	Rx 5C	—	2-28	Tunable	A1; A3; F1; F6	—
	Rx 9B	—	2-28	Tunable	A3; A3a; A3b	—
Stratton	Eddystone 730/4	—	.480-30	Tunable	A1; A2; A3	—
HF TRANSMITTER/RECEIVERS						
B.C.C.	HF 156	2 W.	2.5-8	1 of 6	A1; A3	—
G.E.C.	BRT 430/431	25 W.	2-9.1 (Transmitter) 2-20 (Receiver)	Tunable (6)	Ao; A1; A2; A3	—
Mullard	GNE 510L	40 W.	1.5-12.5	1 of 8	A1; A2; A3	—
	X. 7443	250 W. P.E.P.	2.5-20	1 of 12	A3; A3a	—
Racal	TRA. 55	60 W. P.E.P.	3-12	1 of 4	A2a; A3; A3a	—
Redifon	GR 400	25 W. CW 60 W. P.E.P.	2-10	1 of 4	A1; A3; A3a	—
	GR 49	50 W.	2-10	1 of 5	A1; A3	—
	GR 250	25-50 W.	2-12,5 (Transmitter) 2-25 (Receiver)	1	A1; A2; A3	—
	GR 164	5 W.	2-6 or 4-9	1 of 3	A1; A3	—
	GR 310	1 W.	2.5-8	1 of 4	A1; A3	—

ANCILLARY GROUND EQUIPMENT

	Equipment	Type number	Power Output	Frequency/ Wavelength	Channels	Additionnal Features
B.C.C.	Multichannel Recorder	MARS up to 3 Bay	—	—	up to 20	Up to 24 hours. Time injection; simultaneous play back.
Burndept	Life Saving Beacon (personal carriage)	Talbe	0.6 W.	121.5 Mc/s	1	A2; A3
		Sarbe TRX. 9783	0.5 W.	243 Mc/s	1	A2; A3
		Sarbe TX 10050	0.5 W.	243 Mc/s	1	A2
E.M.I.	Multichannel Recorder	TD. 1	—	—	up to 16	Up to 12 hours recording.
I.A.L.	Beacon Monitor Receiver	IA 246	—	190-510 kc/s	1	Remote indication ; A2; A3
Simon	Multichannel Recorder	LDT 14	—	—	Basic 4	Time injection.
Thermionic Products	Multichannel Recorder	MK I to MK VII up to 3 Bay	—	—	up to 14	Up to 24 hours ; time injection; simultaneous play back.
Ultra	Life Saving Beacon (personal carriage)	SARAH RB2K (Civilian type)	15 W. pulse	243 Mc/s	1	Discrimination provided between beacons. Without speech. 60 miles at 10,000 ft.
	Life Saving Beacon (personal carriage)	SARAH RB5S (Military)	15 W. pulse	243 Mc/s	1	With speech. 60 miles at 10,000 ft.

GROUND RADIO AIDS TO NAVIGATION AND LANDING

	Aid	Type number	Power Output	Frequency/ Wavelength	Approx. Range	Additional Features
Cossor	Gee Chain	Gee Transmitter (Master/Slave)	25 kW.	25-85 Mc/s	Medium	Limited band width.
	Ground Gee Auto-Control equipments		—	—	—	1 of 6 channels. Automatic triggering and locking of Gee transmitters.
Decca Navigator	Decca Navigator Chain	Mark 10	100 W.	70-129 kc/s (limited bands)	300 miles	Pilot interpreted Pictorial Presentation Area Coverage.
Ekco	VDF	CE 178	—	118-148 Mc/s	—	CRT presentation.
G.E.C.	NDB	BRT 452	120-150 W.	200-600 kc/s	—	A1; A2; A3
Marconi	HDF	DFg26/4	—	1.5-21 Mc/s	—	—
	VDF	AD 210A	—	100-156 Mc/s	—	Multichannel. Long-distance remote control.
	VDF	AD 210C	—	100-156 Mc/s	—	Remote Control; 5 push button crystal controlled frequencies.
	Automatic fixer equipment for use with VDFs	—	—	—	—	Up to 6 position lines at one time.

	Aid	Type number	Power Output	Frequency/ Wavelength	Approx. Range	Additional Features
Murphy	Auto-Landing (Azimuth guidance ground installation)	FGRI. 23064	3 KVA (twin cables)	1070-1750 cps	5-6000 ft.	Auto-monitor.
Pye Telecommunications	ILS	PTC 1100				
	Localiser		50 W.	108-112 Mc/s	30 miles	Course and monitoring and alarms. Automatic changeover in event of fault or failure. "Fail safe" alarm system.
	Glidepath		50 W.	328.6-335.4 Mc/s		
	Marker Beacon	PTC 1120	50 W.	75 Mc/s	—	Dual units with automatic changeover in fault or failure.
Redifon	NDB	G55	2 kW.	200-550 kc/s	100-500 n. m.	—
	NDB	G40	500 W.	137.5-550 kc/s	50-350 n. m.	R/T facilities
	NDB	G175A/B	300 W.	200-525 kc/s	50-250 n. m.	R/T facilities
	NDB	G 142	80 W.	200-420 kc/s	10-100 n. m.	—
S.T.C.	VDF	PV1.D	—	100-156 Mc/s	100 miles at 10,000 ft.	Cathode ray Adcock D/F.
	VDF	PQ1A	—	100-156 Mc/s	100 miles at 10,000 ft.	Cathode ray commutated antenna. Either separately or combined.
	UDF	PQ2A	—	225-400 Mc/s	100 miles at 10,000 ft.	UHF/VHF installation also available. High accuracy & immunity from site error.
	Triangulation System	PVT.1	—	—	—	Instantaneous display of aircraft positions on illuminated map-screen. Operates from 2 or more VHF/UHF DFs.
	ILS	STAN 7/8				Freedom from false courses & improved accuracy from dual beam localiser. Transistorized monitor. Highly reliable mechanical modulator.
	Localiser		12 W.	108.1-111.9 Mc/s	75 miles at 10,000 ft.	
	Glidepath		12 W.	328.6-335.4 Mc/s	25 miles at 2,000 ft.	
	Marker Beacon	STAN 9	10 W.	75 Mc/s	—	—
	TACAN	STURN 3	7 kW.	1,000 Mc/s	Medium	—
	TACAN	STURN 4	5 kW.	1,000 Mc/s	Medium	—

GROUND RADAR AIDS TO NAVIGATION AND LANDING

	Aid	Type number	Power Output	Frequency/ Wavelength	Approx. Range	Additional Features
Cossor	Primary Surveillance Radar	CR.21/CR.787	450 kW.	10 cm	Medium	M.T.I. and circular polarisation
	Primary Surveillance Radar	ACR 6	450 kW.	10 cm	Medium	M.T.I., circular polarisation, video mapping. C.R.D.F. display.
	Primary Surveillance Radar	ACR7c	45 kW.	3 cm	Short	Circular polarisation.
	Approach Radar Display System	C.R.D. 23	—	—	—	Interscan markers, video map, C.R.D.F. display, adjustable relative range and bearing.
	Secondary Surveillance Radar	SSR 4G	1 kW.	30 cm	Long	—
Decca Radar	Primary Surveillance Radar	MR. 100	800 kW.	10 cm	Medium	High cover into close range.
	Primary Surveillance Radar	DASR-1	2×800 kW.	10 cm	Medium	Back to back aerial. Variable polarisation. Air target indication.
	Heightfinding Radar	HF.200	2 ½ MW	10 cm	Long	Large target handling capacity with large number of heights/min. Angle of nod varies automatically with target range. R.H.I. and meter presentation.
	Primary Surveillance Radar	424 MK.II	30 kW.	3 cm	Short	Variable polarisation, multi-runway coverage. Available in static, mobile or air transportable versions.
Ekco	GCA	CE 71	10 kW.	3 cm	16 n.m.	"A" scope presentation.
Marconi	Primary Surveillance Radar	S.264 or S.264/H	60 kW.	50 cm	Long	Crystal Control. Coherent M.T.I.
	Primary Surveillance Radar	S.264A or S.264A/H	500 kW.	50 cm	Long	Crystal control of Klystron transmitter. Coherent M.T.I.
	Primary Surveillance Radar	S.255	2.5 MW	30 cm	Long	3 pulse M.T.I.
	Primary Surveillance Radar	S.306	3 MW	10 cm	Long	3 pulse M.T.I.
	Primary Surveillance Radar	S.307	500 kW.	50 cm	Long	3 pulse coherent M.T.I. Crystal controlled Klystron transmitter.
	Primary Surveillance Radar	S.232	60 kW.	50 cm	Medium	Crystal control, coherent M.T.I.
	Primary Surveillance Radar	S 247 consisting of:				
		SR1000	3 MW	10 cm	Long	Back to back aerial system.
		SR1030	3 MW	25 cm	Long	
	Heightfinding Radar	S 244	3 MW	10 cm	Long	Remotely operated from a joystick. 15 height measurements/minute.
Murphy	DME (Secondary Radar, Ground Beacon)	EUREKA 7	1.5 kW.	210-235 Mc/s	Long	Responder Beacon. (Auto-monitor available).
S.T.C.	Precision Approach Radar	SLA 3	50 kW.	3 cm	10-13 ½ miles	17 inch high definition CRT displays. All electronic units duplicated.

ANCILLARY GROUND RADAR EQUIPMENT

	Aid	Type Number	Power Output	Frequency/ Wavelength	Approx. Range	Additional Features
Cossor	Windfinding (Balloon tracking)	CR. 353	250 kW	10 cm	Long	Dial presentation of azimuth, range and elevation. 'A' scope and strobe ranging, optional auto-following, data recorder & P.P.I.
Decca Radar	Air Surface Movement Indicator (A.S.M.I.)	Q-band Radar	12-15 kW	8 mm	Short	Exceptional discrimination of stationary and moving ground targets.
	Ground Weather Radar	40	20 kW nominal	3 cm	Medium	Remote display, camera equipment & iso-echo contouring.
	Ground Weather Radar	41 MK.IIA	20 kW nominal	3 cm	Long	Remote display, camera equipment & iso-echo contouring.
	Windfinding Radar	WF1	20 kW nominal	3 cm	Medium	Full range of reflectors available.
	Windfinding	WF2	75 kW nominal	3 cm	Long	As for WF1. Also one man operation.
Marconi	Short-term weather forecasting aid	SNW 51	50 kW.	3 cm	Medium	Iso-echo camera

AIRBORNE COMMUNICATION EQUIPMENT

	Aid	Type Number	Power Output	Frequency/ Wavelength (Mc/s)	Channels	Additional Features
Burndept	Transmitter/ Receiver	TR.2002 (BE.219)	1⅓ W.	116-126	1	—
	Transmitter/ Receiver	BE.255	1½ W.	118-138	5	—
Elliott	Receiver	E-RA-21A	—	108-136	560	50 kc/s spacing
	Transmitter	E-TA-21A	25 W.	118-136	360	50 kc/s spacing
Marconi	Transmitter/ Receiver	AD 307	100-130 W.	2-24	200	Completely automatic tuning
	Transmitter	AD 305	25 W.	118-136	360	—
	Receiver	AD 704	—	108-135.95	560	—
	Receiver	AD 118	—	2-18.5 .150-.510	Variable frequency	—
Murphy	Transmitter/ Receiver	MR 80	1.5 W.	116-132	23	—
	Transmitter/ Receiver	MR 100	1.5 W.	116-132	36	—
Plessey	Transmitter/ Receiver	PTR 161 Series	1.25 W.	100-140	6	100 kc/s spacing
	Transmitter/ Receiver	AN/ARC 52	20 W.	225-399.9	18	Including Guard Receiver
S.T.C.	Transmitter/ Receiver	STR9Z/100	4 W.	100-156 (specified bands)	44	100 kc/s spacing. Auto-tuning.
	Transmitter/ Receiver	STR.18C1	100 W.	2.8-18.1	100	Pilot controlled 28 V. DC supply.
	Transmitter/ Receiver	STR.12F	10 W.	118.1-131.9	280	50 kc/s spacing
	Transmitter/ Receiver	STR.23	20 W.	Tx = 118-135.95 Rx = 108-135.95	360 560	50 kc/s spacing, partially transistorized.

AIRBORNE EQUIPMENT FOR NAVIGATION & APPROACH

	Aid	Type Number	Power Output	Frequency/ Wavelength	Range/ Channels	Additional Features
Cossor	Airborne Secondary Surveillance Radar	S.S.R.2A	750 W.	30 cm	—	Long range
	Gee Airborne Receiver, Pulse hyperbolic lattice position finding	MK.3	—	25-85 Mc/s	6	Track identification by mechanical counters.
Decca Navigator	Decca Navigator	Decca Mark 9	—	70-129 kc/s (in restricted bands)	9	Extra lightweight pilot interpreted aid.
	Decca Navigator	Decca Mark 8	—	70-129 kc/s (in restricted bands)	9	Pilot interpreted aid.
	Decca Navigator	Decca Mark 10	—	70-129 kc/s (in restricted bands)	63	Main airline pilot interpreted aid with automatic facilities.
Decca Radar	Decca Doppler	61	20 W.	8800 Mc/s	1	100-1000 knots. Altitude 200-50,000 ft.
Ekco	Weather Radar	E 160	60 kW.	3 cm	—	Navigation by map painting.
Elliott	Navigation Unit	E-NVA-21A	—	108-118 Mc/s	20	For VOR/ILS reception; 300 kc/s spacing.
	Glideslope Receiver	E-GSA-8A	—	329.3-335 Mc/s	20	—
	Marker Receiver	E-MKA-7	—	75 Mc/s	1	—
	Airborne Weather Radar	RDR1D	20 kW	3 cm	1	Lightweight
E.M.I.	Secondary Radar	REBECCA MK IV	300 W.	200-240/Mc/s	1	For airborne homing. CRT presentation medium range.
Marconi	Doppler Navigator with comprehensive Computer	AD 2300C	1 W. FM/CW	8800 Mc/s	1	Completely automatic
	Doppler Sensor	AD 2300 A	1 W. FM/CW	8800 Mc/s	1	Completely automatic.
	Doppler Navigator with track guidance Computer	AD 2300 B	1 W. FM/CW	8800 Mc/s	1	Completely automatic.
	Radio Compass	AD 712	—	100-1799.5 kc/s	3,259	Crystal controlled ½ kc/s spacing.
	Radio Compass	AD 722	—	200-1700 kc/s	Variable frequency	Sub-miniature.
	VOR/ILS Receiver	AD 704	—	108-135.95 Mc/s	560	—
	Glide Slope Receiver	AD 706	—	329.3-335 Mc/s	20	—
	Marker Receiver	AD 708	—	75 Mc/s	1	—
	Selective Calling System	Selcal	—	Audio	2	Used with HF and VHF receivers.
	Teleprinter Receiver	AD 308	—	90-150 kc/s	4	For teleprinter operation—transistorized.
Murphy	Secondary Radar Equipment	REBECCA 8B	1 kW.	210-235 Mc/s	—	Distance measuring & heading (meter presentation). Medium Range.
	Auto-Landing (Azimuth Guidance) Airborne Receiver	ARI.23063	—	1070-1750 cps.	—	Auto-monitor. 5-6000 ft.
S.T.C.	ILS/VOR	SR.34/35	—	108-135.95 Mc/s 329.3-355 Mc/s	560 20	To operate with STR.23 Com. Receiver 50 kc/s spacing.
	Marker Receiver	SR.36	—	75 Mc/s	1	—
	ILS/VOR Receiver	SR.32	—	108-117.9 Mc/s 329.6-335 Mc/s	100 20	200 kc/s spacing.
	Marker Receiver	SR.33	—	75 Mc/s	1	—
	Teleprinter Receiver			95-130 kc/s	4	Transistorized.
	TACAN	STARN.21	1.0 to 1.5 kW.	962-1215 Mc/s	126	—
	Radio Altimeter	MK. VII	0.5W.	4200-4400 Mc/s	—	0-500 ft., 0-5000 ft. Accuracy: Low range ±3ft. or ±3%. 1f. at touch down. High range ±30 ft. or ±3%. Partially transistorzed.
	Radio Altimeter	STR.30B1	0.5 W.	4200-4400 Mc/s	—	0-500 ft., 0-5000 ft. Accuracy: Low range ± 3 ft. or ± 3%. 1ft. at touch down. High range ± 30 ft. or ± 3%.
Ultra	Search & Homing Receiver	BR 1101	—	243 Mc/s	1	Location and homing onto SARAH Beacons.
		R.825	—	243 Mc/s	1	Location and homing onto SARAH Beacons. Provides 2-way speech communication with SARAH RB5S Beacon.

Sorry, Mr. Hughes is not at Home...

A twelve-year-old photograph. *Interavia's* Editors are no better off than the staff of America's "Fortune" magazine, who affirmed in the July 1959 issue that Hughes has not been photographed since.

For a banker to be "out of town" to a man who wants money is common enough. But a man who hides from his bankers when they are waiting, cheque-books in hand, to advance him several hundred million dollars, must surely be unique. This unique man is Howard Hughes.

Hughes has half a dozen highly official addresses, including Hughes Tool Co., in Houston, Texas, Hughes Aircraft Co., in Culver City, California, Trans World Airlines, in Kansas City, Missouri—to mention only the most important. He owns houses or bungalows in Hollywood, Houston and other parts of the United States. But if you want a personal interview with him, you probably will not have much more luck than the presidents of his companies or the directors of such investment banking houses as Dillon-Read, Lazard Frères, Lehman Brothers, Merrill Lynch or First Boston Corporation, some of whom have been vainly awaiting an audience for years. In an exceptional case—if you are very persistent—you may get a telephone call from Hughes—and that more likely than not between 10 p. m. and 2 a. m.

Howard Hughes is certainly no lover of close contacts. The writers for the leading business review "Fortune", which devoted a total of twelve pages to the Hughes problem in its January and July 1959 issues, never even caught sight of the hero of their story.

The bankers' urgent desire for a personal talk with Hughes is understandable. There is a little matter of a $320 million commitment, which Hughes entered into three years ago, and which now requires to be put on a sound financial footing. Three years ago, in fact, Hughes ordered 63 jet airliners and supporting equipment for Trans World Airlines (through Hughes Tool Co. which holds 78 percent of TWA's shares). Thirty-three of these were Boeing 707s, costing roughly $186 million, and the remaining thirty were Convair 880s at a figure of $126 million. Boeing delivered the first aircraft early in 1959, but further payments were coming in so hesitantly that Boeing President William A. Allen was obliged to make long telephone calls to Charles S. Thomas, President of TWA. Thomas in turn telephoned the President of Hughes Tool Company. And the banks . . . see above.

If Hughes were a member of that great army of debtors who fail to pay up because they lack the means to do so, there would be no point in writing about the matter. But Hughes is a wealthy man, one of the wealthiest in the world, whose personal fortune was estimated two years ago at some half billion dollars. And if he is unable to come to an agreement with his bankers, this is solely because he cannot make up his mind to divest himself of one iota of his holdings in any of his companies. Not that he is in any sense a miser. Time and again he has laid out hundreds of thousands or even millions of dollars when the question arose of putting one of his ideas into practice: building a mammoth flying boat or a giant helicopter, flying round the world in record time, producing the most gripping film, discovering the most ravishing film star, brewing the best-flavoured beer. No, Hughes is definitely not a skin-flint; but he is equally definitely a cat who walks by himself.

In 1946 Hughes, who personally flew all the aircraft he built, almost lost his life in the prototype of the XF-11, a reconnaissance aircraft of his own design: a broken skull, broken collar bone, eight broken ribs and a torn lung. But Hughes seems to have nine lives . . . both physically and financially.

*

Incidentally, if he were not so infatuated with aviation, Hughes would not be in his present predicament. Hughes Tool Company, founded by his father to produce special oil drilling equipment, is believed to represent a worth of some $300 million. Admittedly the company's profits fell from $29 million in 1956 to $15 million in 1958, but during the first half of 1959 they rose again by more than 25 percent. And after a difficult running-in phase, Hughes Aircraft Co. has developed into a gold mine since it went into the electronics business. Gross income in 1958 reached nearly $500 million. True, Hughes had transferred the capital of Hughes Aircraft to a philanthropic foundation, the Howard Hughes Medical Institute. Yet much of the aircraft company's real estate still remains the property of Hughes Tool Co. And a dissolution of the foundation would reportedly raise no insuperable legal difficulties.

Hughes' only problem child is thus TWA; yet this is the one company which he is determined not to part with at any price. The airline's troubles are by no means restricted to the millions of dollars needed for its new jet fleet. TWA has paid no cash dividend since 1938, and in the three years 1956 to 1958 it suffered losses equivalent to $0.70, $0.23 and $0.26 per share respectively. In July 1959 current liabilities stood at $61.3 million, as against liquid assets of only $17.3 million. And, to make matters worse, the turn of the year 1958/59 saw a stubborn personnel strike.

Of late, however, it looks as if Howard Hughes' tenacity will at last bear fruit. TWA's losses, which continued into the first quarter of 1959, ceased after the first Boeing 707 jets had gone into service and were transformed into a modest profit in the second quarter. This can be described as a well-earned profit, since TWA prepared its jet operations with unmatched thoroughness (maintenance, crew training, ground organization).

Nevertheless, TWA is not yet out of the wood, and the $320 million commitment has still not been consolidated, as is revealed by Hughes' plans to dispose of some of the aircraft he has ordered. He has already agreed to sell six Boeing 707-331s to Pan American for $40 million, and is negotiating with Capital for the latter to take over six Convair 880s at $3.5 million each.

If Howard Hughes had followed the advice of his oldest and staunchest friend, Robert E. Gross, founder of Lockheed Aircraft, such expedients would probably not have been necessary. Robert Gross, whom Hughes had sent to Wall Street as a "scout", came back with a detailed consolidation plan. The house of Merrill Lynch had agreed to handle the public sale of the Howard Hughes Medical Institute's share in Hughes Aircraft Co., and First Boston Corporation had offered to raise a loan backed by the Hughes Tool assets.

It is quite possible that the Gross finance plan will still be put into effect . . . particularly if Hughes thinks that, by accepting it, he can rid himself of the burden of being obliged to make appointments with suppliers, creditors and would-be purchasers. But all this is pure speculation. At the moment . . . Mr. Hughes is "not at home".

These five Fiat G.91s of the 103rd Light Tactical Fighter Group (special unit of the 5th Italian Air Brigade) took part in operational trials of the new NATO strike fighter in northern Italy between June 29th and July 3rd.

The NATO Strike Fighter Shows Its Paces

Tactical Operational Trials of the Fiat G. 91

The two main combat versions: the G.91 lightweight strike fighter (left) and the G.91R tactical photographic reconnaissance aircraft. Both models carry the same weapons.

Less than ten minutes' turn-around time: fuel is pumped into the tanks from a truck, while small cross-country trucks with special trailers return the rearmed weapon packs to the aircraft.

The third and most decisive phase in preparing the new NATO strike fighter for action came to an end a few weeks ago. Two G.91 squadrons of the 103rd Light Tactical Fighter Group of the 5th Italian Air Force Brigade were transferred at short notice from an air base in central Italy to unprepared grass airfields near Udine in the north, where, from June 29th to July 3rd, they put the Fiat strike fighter through tactical operational trials before high-ranking NATO officers and members of the NATO inspection team.

Four hours after leaving their home base, the aircraft took off from the "forward bases" on their first mission, a two-day exercise in which "enemy" ground installations were attacked and communications cut. At heights below 1800 feet and speeds of nearly Mach 0.9 the G.91s swooped on targets such as airports, radar installations and control centres, giving the pilots ample opportunities of displaying the low-altitude manoeuvrability of their aircraft. The programme for the next two days included support of ground forces against surprise attack. After the G.91 R reconnaissance aircraft of the 103rd Group had located and photographed "enemy" dispositions, six strike fighters took off on unbroken attacks against armoured units in the plain and alpine troops among the mountains. In the space of two hours all the aircraft in both G.91 squadrons made at least three sorties, appeared at low altitude over the target zone without betraying their presence by engine noise, and were off again before ground observers were fully aware that they had been attacked.

Finally, on July 3rd, the G.91s gave a target practice demonstration on the Maniago artillery range, where live bombs and rockets were directed onto ground targets. Speed over the target area on all these sorties was around Mach 0.8, which recent experience has shown to be the best speed for evading anti-aircraft weapons of the kind used by enemy mobile ground units. Between attacks the G.91s landed on level ground behind the artillery range, where maintenance crews awaited them with complete ground equipment on cross-country vehicles; less than 10 minutes later they took off again. Four to six men are required for the maintenance of each aircraft, which comprises refuelling and lubrication, renewal of oxygen, fitting the braking parachute, and rearming the weapon platforms with bombs or rockets. *Within a bare 35 minutes four successive aircraft had landed, been rearmed, and taken off again.*

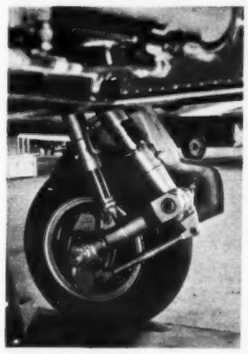
Even before the trials had ended Colonel Driscoll announced that the Fiat G.91 had so far met all SHAPE specifications. Procedures

to cut take-off and landing distances still further were already under consideration, and it was also planned to improve the aircraft's capacity to fulfil the special roles of photographic and television reconnaissance. The manufacturers are, however, of the opinion that as there are in Europe any number of level fields and flat grass strips, motor highways, or even roads about 3,000 feet long, further cuts in the take-off and landing distances of the G.91 production model are unnecessary for the time being. The flying qualities were without a doubt satisfactory in every respect. Although designed to operate primarily at speeds of Mach 0.6 to 0.9, the aircraft could be put into a turn without difficulty at a speed of 150 m.p.h. and immediately afterwards rolled at the rate of 250°/sec. The speed of sound can be exceeded in shallow dives, and accelerations up to 7 g can be achieved for pull-out purposes. Flight stability, already satisfactory, is further improved, particularly when approaching targets, by a built-in yaw-damper.

It is extremely important to have a mobile ground organization with cross-country fuel trucks, personnel and equipment transports and special vehicles for carrying the entire unit (except for the aircraft itself) from one place to another; the latter vehicles must be capable of concealment under trees or behind ground obstructions while the fighters are in the air. The demonstrations at the end of June, in which dozens of these cross-country vehicles took part, showed that the vehicle fleet has already been greatly improved.

Landing on the grass strip of an auxiliary base near Udine, in northern Italy. The Fiat approaches the strip at a speed of about 150 m.p.h., but stops only a few hundred yards after touching down.

The weapon packs at either side of the fuselage can be removed and reinstalled in four minutes with the aid of a lifting and transport trailer, so that in an emergency the pack can simply be removed and replaced by a new, completely restocked one, while the used platform is taken back to the ammunition tent.



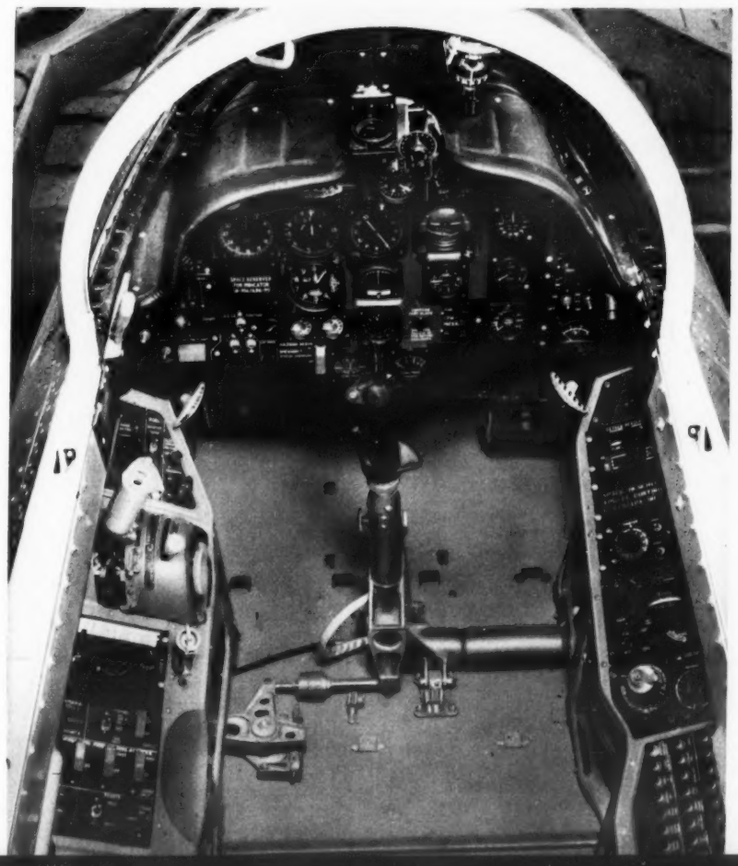
Nosewheel and main undercarriages meet the strict requirements for operation on semi-prepared strips. Articulated wheel-forks and highly-sprung shock absorber legs damp perpendicular and tangential impact stresses. The low tyre pressure (nosewheel 42.6 lb/sq. in., main wheels 49.7 lb/sq. in.) considerably facilitates taxiing on semi-prepared or grass strips.

The nose of the G.91R tips down to reveal the cameras. They consist of a camera pointing forwards, one pointing downwards and two lateral cameras. The windows in the nose are deiced and kept dry by warm air.

The heaviest replaceable part of the G.91, the Bristol *Orpheus* jet, can be transported by standard NATO helicopters, as was shown by a German Air Force Vertol 21. During the Udine operation the trial fighter unit received effective support from tactical STOL and VTOL aircraft, including three Vertol helicopters (one each from the German Army, the German Air Force and the manufacturers) and two Dornier Do 27s, which performed certain transport duties and flew in advance of the unit to look for take-off and landing fields.

*

Official observers and members of the inspection team for the new NATO lightweight strike fighter came to northern Italy with requirements for a robust, economical and easily handled aircraft for use by highly mobile units. The first demonstration of the complete G.91 weapons system appears to have shown that, tactically and operationally, the single-seat Fiat has fulfilled the promise shown at the technical trials at Brétigny two years ago.



The cockpit layout is based on NATO recommendations and USAF experience. *To pilot's left*, on a seat-level console: levers, buttons and switches for releasing air-to-surface weapons and loads (and taking photographs in the case of the G.91R, illustrated here), radio tuning, power and flap controls, trimwheel and engine starter. *In front of pilot:* engine and flight monitoring instruments, reflector sight and other camera controls. *To pilot's right:* oxygen regulator, switches for IFF equipment, ADF, air conditioning, and fuse-board. Length of cockpit 4.98 ft; width 2.3 ft.

After San Diego... ICAO Forges Ahead

By L.C. Boussard, Chief, Public Information, ICAO, Montreal

Meeting place in San Diego.

The ICAO Assembly's deliberations and decisions during its twelfth session at San Diego show, first and foremost, that this specialized agency of the United Nations is resolutely tackling the international problems raised by the constant development of aviation in both its technical and economic aspects. Secondly, shifts in the world political situation were reflected in significant changes in the composition of the ICAO Council, which can be described as the international aviation Cabinet, while the Assembly is the international aviation Parliament.

San Diego witnessed something that has not been seen for years: lively competition for election to seats on the supreme executive organ, amounting almost to a battle, which did not escape the attention of observers. The campaign, launched by the delegates of the smaller countries of South America at Caracas three years ago, but too late to be effective, was conducted eloquently and actively at San Diego by the representatives of these countries, particularly by Dr. J. J. Lugo, the spokesman for Nicaragua. It ended in victory when Guatemala succeeded, after a tough struggle, in obtaining a seat on the Council in place of Mexico. Secondly Belgium and Ireland were replaced by Germany and the Philippines, who will in future take a more active part in the work of ICAO. The results of the San Diego elections are gratifying not only to those who had maintained—doubtless ironically—that the ICAO Council was one of the most conservative and exclusive clubs in the world, but also to those who had demanded more balanced geographical representation on the Council, where they considered the European countries had too strong a numerical position. The Philippine delegate to Montreal will take pride in realizing that he is also the representative of a vast region of the world where aviation plays an increasingly important role.

The re-election of Council President Walter Binaghi, who has long been considered an outstanding technician, surprised nobody. It can be regarded as the homage due to a reputed engineer who, with all personal modesty, has shown himself to be a worthy successor to Dr. Edward Warner. All unite in recognizing his absolute impartiality and the skill with which he conducts—if necessary in three languages—the most difficult debates on matters of either principle or detail. Moreover, there is always much to be gained by retaining a man in office, since he can not only cope with current business, but also himself study the real and concrete difficulties which must be overcome rapidly if the march of progress is not to be retarded.

E. R. Quesada (USA), President of the Assembly session.

Walter Binaghi (Argentina), President of the ICAO Council.

What most struck observers at San Diego was the attitude taken up, from the early days of the session, by the United Kingdom delegation, who maintened in no uncertain terms that it was all very well to be talking about jet aircraft, but that it was also essential and urgent to tackle the question of supersonic aircraft without delay, so as not to be caught napping when, in the not-far-distant future, these aircraft are introduced into the air transport industry. The Council has now been instructed to undertake the necessary studies and to estimate the probable repercussions of the evolution of aviation during the coming

Carl Ljungberg (Sweden), retiring ICAO Secretary General (left) and his successor R. M. Macdonnell (Canada).

R. O. Amuaka-Atta (Ghana).

USA delegation (left to right) L. C. Vass, E. R. Quesada, C. Gurney, B. D. Nash.

Dr. J. J. Lugo (chief delegate from Nicaragua) in conversation with Council President Binaghi.

15 years, in the technical, economic and social fields. The study will deal in particular with the problems of noise, the dimensions of runways, etc..., so that governments can make a concerted effort to avoid chaos, with full consideration for the interests of the public, operators and civil aviation authorities. The Council must recognize that one of its essential tasks will be to remind manufacturers and operators that future aircraft must be designed to operate without entailing serious social upheavals and with due regard to the costly installations which all major airports will by then have acquired.

The decision to undertake a study of expected developments during the next 15 years was taken in circumstances which should be recorded. The United Kingdom delegation, having made known its basic attitude at the very beginning of the session, later submitted a detailed and explicit proposal, not only in its own name but also on behalf of Australia, Belgium, Denmark and Germany. Anticipating certain difficulties, the U.K. delegation had declared itself ready to soften the terms of this proposal, when the French, Belgian and Mexican delegates in the Administrative Commission persuaded the majority of their colleagues to vote in favour of the original British proposition and ignore the "watered-down" version. The United States delegation opposed the proposal in the Administrative Commission (though it did not insist on its views in the full Assembly), apparently because in its opinion the proposed study might lead to the adoption of excessively rigid standards and requirements so strict as to hamper manufacturers, since it would be difficult for an ICAO member State to certificate aircraft which did not meet ICAO recommendations.

In short, the United States delegation saw in the study, or rather in the possible consequences of the study, an eventual brake on research and production. This explains its attitude during the preliminary debates.

At any rate the decision reveals that the ICAO Assembly, which three years ago had only just managed to cope with the problems of the jet age—setting up the famous Jet Age Task Force, whose final report was presented at San Diego—is now fully aware of the difficulties which may accompany new discoveries in aviation and has also realized that only international action can avoid delays and confusion.

It is also very significant that, when discussing the various solutions offered by the Council and the Task Force, the representatives of the 62 member States who had sent delegations to San Diego should have decided that a system of joint financing must be applied to such jet age problems as are still unsolved.

As regards jet aircraft operation, all is not for the best in the best of all possible worlds. There are still very serious deficiencies at most of the international airports, even at London and New York. In the United States jet aircraft are still flying at altitudes of 29,000 feet, despite the fact that under optimum conditions they should operate at 39,000 feet—simply because there are difficulties between the civil and military authorities. Jet aircraft are also flying at speeds below those which had been planned. Fuel consumption exceeds earlier estimates by 20 percent, which would have catastrophic results if this state of affairs were to persist. These major problems, all of them well known, exist in regions where jet transport is now regarded as an everyday matter. If the benefits of jet transport are to be extended to all parts of the world, even more serious difficulties must be anticipated. The experts on ICAO's Task Force consider that it would cost no more than 5 to 6 million dollars to remedy the worst defects. But it must be remembered that there are certain countries which either do not need jet services or simply do not have the funds to provide the necessary installations. There cannot be full utilization of jet transport until solutions are found to the problems of upper air and terminal meteorological information, navigation aids, ground organization, specialized personnel, telecommunications and air traffic control services, and noise. Hence the need for urgent measures, and the Assembly's decision to ask the Council to give top priority to these problems. Taking into account the information already held by the Air Navigation Commission, and assuming that States will lose no time in notifying Montreal of what they feel able to do and what they do not feel able to do, there is every reason to hope that two joint financing conferences can shortly take place, one in the Far East and the other in South America.

Another extremely interesting debate, which has already received considerable comment, took place in the Economic Commission and was continued in a heated atmosphere during one of the plenary sessions of the Assembly. Certain European States had succeeded in persuading the Economic Commission to agree that it was not ICAO's affair to concern itself with statistics of air passenger's points of origin and destination. This is not a new subject. A proposal that ICAO should undertake this task had been made earlier at a Division meeting in Montreal. What actually is the problem? The U.S. airlines and the U.S. Government—in other words the companies and the government of the country which so to speak puts the largest number of air passengers into circulation—make no secret of the fact that they would like to know how many American passengers are carried from one point on the globe to another, and in particular across the North Atlantic, by certain European companies, particularly the Belgian, Dutch and Scandinavian airlines; similarly Brazil appears to desire precise figures on the number of Brazilian passengers carried by the U.S. airlines, and Spain would like to know how many Spanish passengers are transported by the Brazilian companies. Fundamentally, the whole debate centres round the question of whether, on the basis of official statistics prepared by the International Civil Aviation Organization, certain governments might not be encouraged, when renewing their bilateral air transport agreements with other governments, to insist on certain clauses, most probably of a restrictive nature, concerning passenger quotas. In full session the Assembly was to decide that ICAO should study this question of statistics of origin and destination.

*

These, then, were the main questions raised and the solutions approved by the international aviation parliament at San Diego. It would be foolish to minimize their importance. It would also be foolish to deny the evidence and to fail to recognize that despite predicted difficulties—the direct result of full freedom of action within the framework of international life—ICAO is not resting on its laurels, but is continuing to forge ahead.

U. B. Caldoza (Philippines).

The German delegation (left to right): Dr. F. U. Schmidt-Ott, H. K. Kallus (chief delegate), Dr. F. Hentschel.

Sir Arthur de T. Nevill (New Zealand's chief delegate).

French delegates (left to right) Henri Bouché (French representative on the ICAO Council) and André Garnault.

Rear views of the GAM-77 Hound Dog *air-to-surface missile, which North American is producing in quantity for SAC's B-52 jet bombers. Beneath the airframe rear is the Pratt & Whitney J52 jet (8,600 lb thrust). The* Hound Dog *is transported on the special trolley shown here and is suspended underneath the B-52's wing by a streamlined pylon.*

Rockets, Missiles and

• Saturn prototype by 1960?

The Advanced Research Projects Agency has now confirmed details of the 200-foot *Saturn* space vehicle and announced the names of the major subcontractors on this giant project.

As already reported, the first stage of the *Saturn* will comprise eight clustered Rocketdyne H-1 engines. The first version of these engines will deliver 150,000 pounds of thrust each, but a more advanced version will have 165,000 pounds. The eight individually swivelling engines should be ready for testing by the Army Ballistic Missile Agency at Huntsville, Alabama, in December this year. Eventually, after still further development, a total ground thrust of 1,500,000 pounds is aimed at. The second stage will consist of the liquid oxygen/kerosene first stage of the *Titan* ICBM, and the third stage will be the *Centaur* which Pratt & Whitney is developing for liquid oxygen and liquid hydrogen operation.

The complete *Saturn* vehicle will weigh about 530 tons on lift-off, of which 450 tons will consist of fuel and oxidizer. The first stage will stand 75 feet high and have a diameter of 22 feet. The second stage will be slightly longer than the 54 feet of the production *Titan* first stage, and its two engines will supply a total of 360,000 pounds of thrust. The two Pratt & Whitney engines in the third stage will have a combined thrust of 30,000 pounds. A fourth stage may be added to the booster, possibly the 6,000-pound thrust storable propellant stage now under development by NASA's Jet Propulsion Laboratory.

ARPA's present plan is that the *Saturn* satellite vehicle should be ready by 1962/63, so as to enable the United States to lift a 19,000-pound payload into a low orbit or place 3,300 pounds of instruments in a "stationary" equatorial orbit 22,000 miles up.

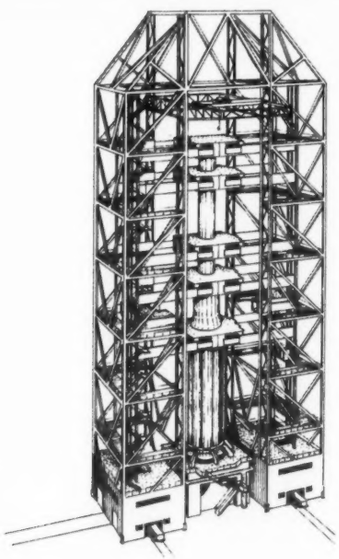
The Army Ballistic Missile Agency is modifying its 145-foot tower at Huntsville in order to conduct tests on the clustered powerplant. Meanwhile, a 305-foot self-propelled service stand is under construction at Cape Canaveral, Florida (see picture), where the first free flight tests will be carried out. So far ARPA has authorized construction of one first stage cluster for static tests at Huntsville, plus four flight models for actual firing. The first two flight models will use dummy upper stages, while the third and fourth may include the *Titan* second stage. A total of $34 million has already been committed for the programme, and the first flight date is scheduled for late 1960.

It is also learned that Cook Electric Co., of Morton Grove, Illinois, is developing a special recovery system for the *Saturn* booster to permit post-flight inspection and possibly further use of the giant rocket. The system employs both parachutes and retro-rockets.

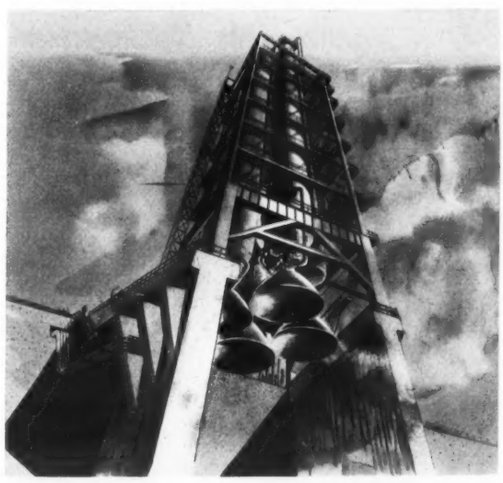
• The British satellite programme

Sir Edward Bullard, Chairman of the Steering Group on Space Research, has confirmed that the United Kingdom and the United States have signed an agreement on cooperation in satellite research. The first British satellite, he said, would be launched in an American solid-propellant *Scout* rocket in the United States in about two years' time. Design and development of equipment for Britain's first satellite is due to begin within six months, and it is planned to conduct some ten to twelve space experiments under a four-year programme to cost between £100,000 and £200,000 annually.

The first British satellite will probably have a maximum diameter of about 20 inches, with a payload of 150 pounds, and will orbit at a height of approximately 300 miles. At least five satellites will be built when design studies are completed. The programme primarily covers research into the ionosphere, radio astronomy, ultra-violet radiation from the sun, infrared radiation, the earth's magnetic and gravitational field and micro-meteorites.



The U.S. Army Corps of Engineers has announced plans for construction of a 305-foot self-propelled tower (on wheels) for the Saturn *space rocket. The steel rig, to be built at Cape Canaveral under ARPA contract, will have two workshops, several lifts and cranes, a launching platform and extensive test equipment. It will enable final assembly, launching preparations and actual launching of the giant* Saturn *to be carried out on the spot.*



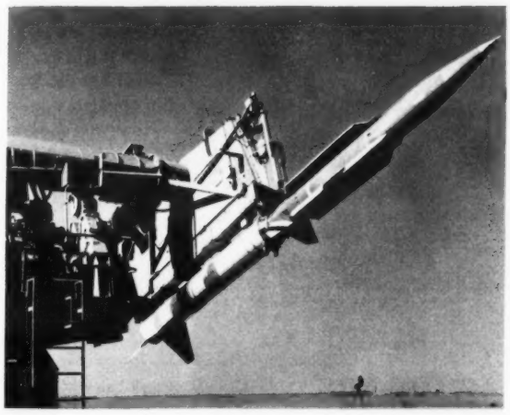
The Facilities Engineering Division of Aerojet-General Corporation has designed a static test stand for rocket engines of up to 1,500,000 pounds thrust, under contract to the U.S. Army Corps of Engineers. The test stand is to be erected at Edwards AFB, California, and will be capable of test firing four of these engines simultaneously.

Space Vehicles

A supersonic missile target for operation at altitudes of 5,000 to 70,000 feet is under development at Beech Aircraft Corporation. Designated the KD2B-1, the rocket-powered drone will have a speed of around Mach 2 and—the manufacturers claim—can be produced in quantity at the low unit cost of $ 20,000. The design was chosen for development from among 18 projects submitted for a Navy/Air Force competition.

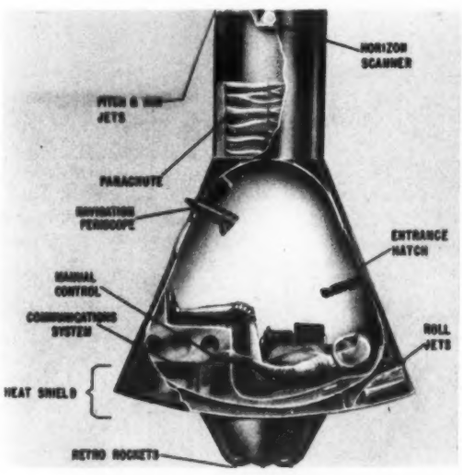
This new six-stage research rocket is being used at Wallops Island to study re-entry problems under a joint NASA/ARPA programme. The first three stages (Honest John, Nike-Ajax *and* Lance) *carry the vehicle to an altitude of 200 miles. The fourth stage, a Thiokol T-40 rocket, is mounted at the tip of the vehicle (with thrust direction downwards) and propels the fifth stage and the spherical payload (sixth stage mounted on top of the* Lance *rocket) earthwards.*

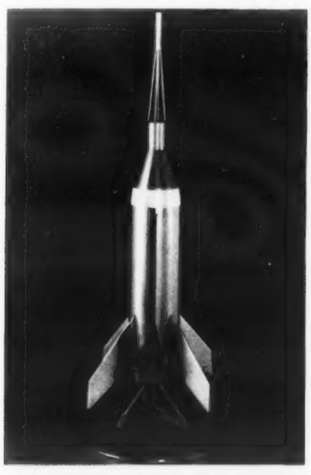
A test model of the Temco XASM-N-8 Corvus *air-to-surface missile was fired for the first time in mid-June, from a Navy Douglas A4D* Skyhawk. *Designed for use against surface vessels and coastal installations, the* Corvus *is reportedly a long-range weapon, capable in particular of steering towards enemy radar antennas. Temco Aircraft Co. is the main contractor; major subcontractors include Reaction Motors Division of Thiokol (pre-packaged liquid-propellant rocket engine), Texas Instruments and W. L. Maxson Corp. (electronic equipment), Douglas' Tulsa Division, Avion Division of ACF, and Bulova Research Laboratory.*



Convair has published this first picture of the improved Terrier *surface-to-air missile, now in production for the U.S. Navy at the Naval Industrial Reserve Ordnance Plant, Pomona, California. The new* Terrier *still has a solid-propellant booster, but the earlier cruciform wings in the centre of the fuselage have been replaced by four long trapezoidal vanes, apparently carrying built-in antennas, just ahead of the tapered, swivelling tail vanes. The missile will be used by at least 27 U.S. Navy warships, but is also projected for land use.*

The multi-stage solid-propellant Little Joe *booster (below, centre and right) to be used for testing NASA's* Mercury *satellite capsule (left) should be ready for first trial shots with a dummy capsule this autumn. These tests are to be made from Wallops Island Research Station. During the winter an actual capsule may be launched, perhaps carrying animals. The Missile Division of North American is responsible for constructing the booster and its launching platform. The full-size satellite capsule and its booster will together measure 44.5 feet in length. The booster casing, which is stabilized by four swept fins, will contain four* Castor *rockets and four* Recruit *rockets, with a total thrust of roughly 372,000 pounds. The two types of rocket will be arranged in such a way that each can be ignited separately. For launching, two* Castors *with a combined thrust of 120,000 pounds will be ignited first, followed a bare half second later by all four of the* Recruit *rockets, with a total additional thrust of 132,000 pounds. The remaining two* Castors *will be fired automatically when the four* Recruits *and first two* Castors *have burned out. For all tests the* Mercury *capsule will carry at its tip the recovery rocket shown in the centre picture.*





A Catalogue of the Space Age

Earth and Sun Satellites since 1957

The successful launching of two new American earth satellites—Explorer VI and Discoverer V—in the first half of August brings the number of space vehicles in orbit up to nine and throws the subject of the following articles once more into the limelight. As data for the two latest satellites were not available when the accompanying table was prepared, main details are given here: *Explorer VI* (also known as Paddlewheel) was launched at Cape Canaveral, Florida, on August 7th, 1959, and carried into a highly elliptical orbit (perigee 156 miles, apogee 26,400 miles) by a three-stage *Thor-Able* rocket. The satellite has four paddle wheels set cross-wise and spanning a total of 8 feet; each side of these paddles carried 1,000 solar cells to provide power for the 40 watt transmitter. Weight in orbit is 142 lb., period 12 hours 45 minutes, expected life at least one year. *Discoverer V* (details not yet complete) was raised into a polar orbit by a *Thor-Hustler* two-stage rocket, from Vandenberg AFB, California, on August 13th. Total weight approx. 1,700 lb., payload approx. 300 lb., perigee 136 miles, apogee 450 miles, period 94 minutes, programmed life of re-entry capsule 17 orbits.

Nearly two years ago, on October 4th, 1957, the Soviet Sputnik I inaugurated the Space Age. That since then two dozen artificial satellites have circled the earth and half a dozen rocket vehicles have penetrated outer space, is nowadays accepted as a matter of course, nor are we surprised to learn that the USA is building giant rockets of 2,750 tons launching thrust for manned space trips to neighbouring planets. Not only are satellites being used to sound ambient conditions for future space travellers, but they are already planned to take part in experiments to check Einstein's theories of relativity... Will the voyager through the universe, returning from a trip to the nearest fixed star, really have remained younger than his relatives who have stayed behind in New York or Moscow?

For the time being, however, American and Soviet rocket experts have more pressing matters on their minds, such as communications and reconnaissance satellites for use as military outposts. But their programmes have yet another goal: to reveal to science the mysteries of both the universe and the atom. The accompanying table, in particular the information on the great variety of measuring equipment contained in the satellites and space probes, reveals four main aims in present and future development:

1 Geophysical, geomagnetic and radiological investigations outside the atmosphere, which concern primarily the exact sciences and give a better understanding of the structure of the universe;

2 High altitude meteorological observations for forecasts of the overall weather situation;

3 Military communications, reconnaissance and early warning;

4 The testing and perfecting of aids to manned space flights.

Once the fever of international competition is spent, the development of *manned* space flight should proceed along more orderly lines and, it is hoped, lead to a businesslike working programme. What is certain is that future space experiments will, in the long run, be prompted less by economic necessity than by the oldest and, so to speak, the most primitive motive for all human progress: the thirst for knowledge and adventure. Meanwhile, tribute is due to the engineers and scientists who have played so important a part in the developments of the past two years, which are reviewed in the following pages.

*

In the early days of October 1957, to the complete surprise of the West, the first Soviet earth satellite was launched from a ramp somewhere north of the Caspian Sea, apparently with the aid of a two-stage rocket on which the Russians have still issued no details. No less astonishing than this early launching was the weight of the *first Sputnik* (184 lb), which circled the earth in about 96 minutes at an angle of 65 degrees to the equator and remained in orbit for three months. Following *Sputnik I* on its lonely course at a height of 140 to 590 miles were the burnt-out final stage of the booster rocket and the cast-off nose cone. The weight of all three was reportedly about 4 tons—a noteworthy achievement for Russian rocketry when it is considered that this weight had to be accelerated to a speed of 18,000 m.p.h.

Until October 27th, 1957, two transmitters radiated intermittent signals on frequencies of 20.005 and 40.002 Mc/s, which not only enabled the satellite to be tracked from the ground but also provided certain data, as pressure and temperature gauges installed inside the satellite changed the signal frequency and the ratio between the pulse length (approx. 0.3 sec) and pulse interval (also about 0.3 sec).

The world's press was still commenting on the military and political implications of the first Soviet earth satellite, when, on November 3rd, 1957, the Russians launched the *second Sputnik*, this time with a live dog on board.

Survey of Earth Satellites and Space Probes

(as at the beginning of July 1959)

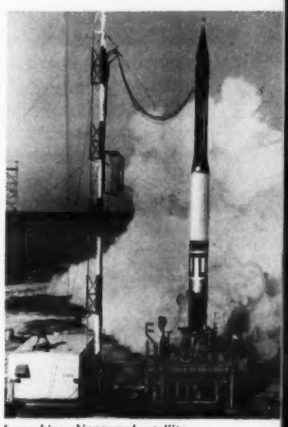
Name, country of origin, total orbit weight Wt payload weight Wp	Launching date and lifetime	Launching vehicle	Payload	Test Results P = perigee A = apogee
SPUTNIK I (USSR) Wt approx. 4 tons Wp = 184 lb.	Oct. 4th, 1957 to Jan. 4th, 1958	Not disclosed	*Shape:* spherical; *diameter:* 22.8 in.; *shell:* aluminium alloy; *instrumentation:* internal temperature and pressure elements; *transmitters:* 20.005 Mc/s and 40.002 Mc/s, each with 1 watt output; *power supply:* chemical batteries; *antennas:* 4 spring-loaded whip antennas 7.9 ft. to 9.5 ft.	Period 96.17 min; speed (perigee) 18,000 m.p.h.; speed (apogee) 16,200 m.p.h.; angle of trajectory to equator 65°. P = 142 miles A = 588 miles
SPUTNIK II (USSR) Wt = approx. 4 tons Wp = 1,120 lb.	Nov. 3rd, 1957 to April 14th, 1958	Not disclosed	*Shape:* capsules joined by struts; *dimensions:* not disclosed; *capsule shells:* aluminium alloy; *instrumentation:* instruments for measuring cosmic, ultra-violet and X-ray radiation, temperature and pressure elements, dog (Laika) with physiological measuring instruments; *transmitters:* 20.005 Mc/s and 40.002 Mc/s, 1 W each; *power supply:* chemical batteries; *antennas:* not disclosed.	Period 103.7 min; speed (perigee) 18,000 m.p.h.; speed (apogee) 15,000 m.p.h.; irregular accelerations and delays led to the discovery of solar influence on the density of the upper atmosphere. P = 140 miles A = 1,038 miles
VANGUARD TV-3 (USA) Wt = 3.4 lb.	Dec. 6th, 1957 0	U.S. Navy Vanguard TV-3 three-stage rocket; gross launching weight 22,600 lb; height 72 ft; diameter 45 in.	*Shape:* sphere; *diameter:* 6 in.; *shell:* magnesium-aluminium-silicon monoxide; *instrumentation:* micrometeorite impact counters; *transmitters:* 108.00 Mc/s (10 mW) and 108.03 Mc/s (5 mW); *power supply:* mercury batteries and six groups of solar converters; *antennas:* 1 dipole with six 12 in. rod elements, one turnstile antenna.	Thrust lost after two seconds burning period. Explosion on launching pad.

Sputnik I *at the Moscow All-Union Industry Exhibition.*

Container for Laika in Sputnik II.

Name, country of origin, total orbit weight Wt payload weight Wp	Launching date and lifetime	Launching vehicle	Payload	Test Results P = perigee A = apogee
EXPLORER I (USA) Wt = 30.8 lb. Wp = 18.13 lb.	Jan. 31st, 1958 3 to 5 years	U.S.Army 4-stage *Jupiter C* rocket; height 68.6 ft.	*Shape:* cylindrical, with conical nose; *length:* 80 in.; *diameter:* 6 in.; *shell:* steel with 8 aluminium oxide strips; *instrumentation:* Geiger counter, micrometeorite impact counter, temperature elements; *transmitters:* 108.00 Mc/s (10 mW), 108.03 Mc/s (60 mW); *power supply:* mercury batteries; *antennas:* turnstile antenna with 4 whip elements; dipole antenna using satellite skin.	Period 114.8 min; angle of trajectory 33.34°; discovery of radiation belt round earth with equipment supplied by Dr. Van Allen. P = 224 miles A = 1,573 miles
VANGUARD TV-3 (USA) Wt = 3.4 lb.	Feb. 5th, 1958 0	Vanguard TV-3 three-stage rocket	As first Vanguard TV-3.	Failure of control system after 57 sec. climb and break-up of rocket stages at an altitude of 20,000 ft.
EXPLORER II (USA) Wt = 31.51 lb. Wp = 18.83 lb.	March 5th, 1958 0	*Jupiter C* four-stage rocket	*Shape:* cylindrical, with conical nose; *dimensions:* as *Explorer I; shell:* stainless steel; *instrumentation:* micrometeorite impact counter, Geiger counters, shielded and unshielded; *transmitters:* as *Explorer I; power supply:* mercury batteries; *antennas:* two dipoles using satellite skin.	Last stage failed to ignite; satellite fell into the Atlantic after 823 sec flight time.
VANGUARD I (USA) Wt = 50 lb. Wp = 3.25 lb.	March 17th, 1958 200–1,000 years	Vanguard TV-3 three-stage rocket	*Shape:* sphere; *diameter:* 6.4 in.; *shell:* aluminium alloy; *instrumentation:* temperature element; *transmitters:* 108.00 Mc/s (10 mW), 108.03 Mc/s (5 mW); *power supply:* mercury batteries and 6 solar converters; *antennas:* turnstile antennas and one dipole with six 12-in. rod elements.	Usefulness of solar converter proved. The U.S. Army Map Service is using *Vanguard I* to correct earlier geodetic surveys in the Pacific area and for the exact determination of the earth's contours. P = 409 miles A = 2,453 miles
EXPLORER III (USA) Wt = 31.0 lb. Wp = 18.56 lb.	March 26th, 1958 to June 27th, 1958	*Jupiter C* four-stage rocket	*Shape:* cylindrical; *dimensions:* as *Explorers I* and *II; shell:* steel, with 8 aluminium oxide strips; *instrumentation:* radiation counter with magnetic tape recorder, micrometeorite counter, temperature elements; *transmitters and power supply:* as *Explorers I* and *II; antennas:* as *Explorer II.*	Period 115.87 min; angle of trajectory 33.4°; provided valuable supplementary information on micrometeorite density and the radiation belt discovered by *Explorer I.* P = 121 miles A = 1,746 miles
VANGUARD TV-5 (USA) Wp = 21.5 lb.	April 28th, 1958 0	Vanguard three-stage rocket, similar to TV-3	*Shape:* sphere; *diameter:* 20 in.; *shell:* highly polished silicon-monoxide-coated magnesium; *instrumentation:* X ray counter; *transmitters:* as *Vanguard I; power supply:* as *Vanguard I; antennas:* 4 metal rods.	Failure of two electric relays prevented the third stage from igniting.
SPUTNIK III (USSR) Wt approx. 7,000 lb. Wp = 2,134 lb. (2,925 lb. incl. shell)	May 15th, 1958 approx. 15 months	Not disclosed	*Shape:* conical with spherical baseplate; *length:* 11 ft. 9 in.; *diameter:* 5 ft. 8 in.; *shell:* aluminium alloy; *instrumentation:* 1. magnetometer; 2. photomultiplier to record sun's corpuscular radiation; 3. solar batteries; 4. equipment for recording photons in cosmic rays; 5. ionization manometer; 6. ion trap; 7. electrostatic tension meter; 8. mass spectrometer; 9. equipment for recording heavy nuclei in cosmics rays; 10. equipment for measuring the intensity of heavy cosmic radiation; 11. micrometeorite counter; *transmitters:* 20.005 Mc/s and 40.01 Mc/s (2nd frequency is harmonic of 1st); *power supply:* chemical batteries and solar converters; *antennas:* folded dipole and trailing rod antennas.	Period 106 min; angle of trajectory 65.3°; speed (perigee) 18,837 m.p.h.; speed (apogee) 14,637 m.p.h.; interesting information on gas traces and concentration of ions, extent and intensity of radiation in the exosphere.

Explorer I *is mounted on the final stage of the* Jupiter C *rocket.*



Launching a Vanguard *satellite rocket.*

Vanguard *miniature satellite, 6 inches in diameter.*

In the dog's pressurized cabin were instruments for measuring heartbeat, blood pressure, respiration and body temperature, and the values recorded were transmitted continuously to the ground. For a time Laika the husky was fed intravenously and supplied with water orally via a hose. About two weeks later, when supplies were exhausted and the batteries had given out, communication with the "coffin" was cut off; on April 14th, 1958, the satellite plunged into the denser layers of the atmosphere, burnt itself up and was reduced to dust. During this time, however, special instruments had recorded vital data on ultra-violet rays, solar rays and cosmic radiation, proving that solar activity had a definite influence on the density of the upper layers of the atmosphere. Long after the second artificial moon had ceased to exist rocket engineers in the West were still racking their brains to find out how the Russians had managed to put *Sputnik II,* with its 1,120-lb payload of instruments and equipment, into an orbit with an apogee of 1,040 miles.

When, on December 6th, 1957, the U.S. Navy, to a certain extent under the pressure of American public opinion, tried to launch its first *Vanguard miniature satellite* weighing 3.4 lb, the attempt ended in flames and smoke. Only two seconds after leaving the Cape Canaveral launching pad the first stage of the Martin TV-3 booster exploded.

American hopes now turned to the U.S. Army, which had quietly and unobtrusively been preparing to launch an artificial satellite weighing 30.8 lb. The launching took place on January 31st, 1958, when the cylindrical *Explorer I,* powered by a converted *Redstone* rocket and several solid-fuel rocket motors, became the first Western satellite to go into orbit. *Explorer I,* on its highly eccentric orbit with an apogee of 1,573 miles, will circle the earth for several years. In spite of its relatively low weight (the instrument payload was only 18.8 lb) this Army satellite was responsible for the most important discovery of the International Geophysical Year: the existence of a belt of radiation round the earth's equator. The simple measuring equipment carried by *Explorer I* was designed by Dr. James A. Van Allen, Head of the University of Iowa Physical Department, who later published a convincing theory of this extraordinary phenomenon.

Unlike the first miniaturized *Vanguard, Explorer I* was not fitted with solar batteries, but only with normal chemical batteries, so that the 108 Mc/s transmitter (with 10 mW output power) fell silent after some months, and the 108.03 Mc/s transmitter (with 60 mW output power) after only a few weeks. Nevertheless this first success gave an impetus to further projects for space radiation measurements. Moreover, the *Explorer* experiment showed that the temperature inside a small artificial satellite could be regulated, and that micrometeorites appear to offer no appreciable risks to future space travellers.

Meanwhile the U.S. Navy's *Vanguard* programme was still dogged by illluck. A *second Vanguard booster* (to replace the TV-3 which had exploded) was

launched at Cape Canaveral on February 5th, 1958, carrying the 3.4 lb "grapefruit"; everything went according to plan until the satellite reached a height of 20,000 ft, when, after a flight period lasting 57 seconds, the individual rocket stages broke apart due to a fault in the control system and fell to the ground. The U.S. Army, too, had to write off its *second Explorer launching* as a failure. As the fourth stage of the *Jupiter C* failed to fire, the satellite fell back to earth before reaching its prescribed orbit.

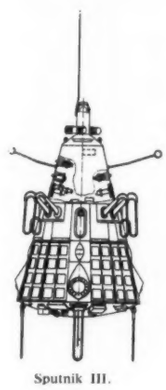
Then, however, the U.S. Navy had a lucky break. On March 15th, 1958, the miniature *Vanguard I* was launched from the Atlantic missile firing range at Cape Canaveral, using a booster similar to the TV-3; this satellite was a small aluminium sphere with a diameter of 6.4 in., weighing 3.25 lb and containing tiny mercury batteries, a solar energy storage unit, transmitters and instruments. Because of its high orbit (perigee 409 miles, apogee 2,453 miles), the satellite is expected to have an extremely long life, according to scientists' estimates between 200 and 1,000 years. The use of a solar transformer as a source of current for the 108.03 Mc/s transmitter was justified, for as long as *Vanguard I* circles the earth, the small 5-milliwatt transmitter will be operating and indicating any alterations which may occur in the satellite's orbit. The U.S. Army's map service is already using the *Vanguard I's* signals to correct inaccuracies in existing maps and current notions of the earth's contours. The clockwork regularity of the artificial satellite's motions has already led to the discovery of errors of as much as a mile on maps of the Pacific region.

As the only instruments carried by *Vanguard I*, other than transmitters, were temperature devices, the Army, anxious to continue its space radiation measurements, put into orbit *Explorer III*, powered by a *Jupiter C* rocket, on March 26th, 1958. Equipped with instruments and transmitters weighing a total of 18.56 lb, the satellite reached an apogee of over 1,700 miles and a perigee of 120 miles. The wide range of heights covered enabled it to measure cosmic radiation, micrometeorite density and temperatures inside and outside the cylindrical body of the satellite. A new feature was that all measurements were recorded on a magnetic tape so that they could be played back in answer to "inquiries" from ground stations. In this way measurements were assured during the entire orbital period and not merely when the satellite was directly above a ground monitoring station. By means of the data storage technique American scientists perfected their knowledge of the belt of radiation round the earth; their Soviet colleagues, on the other hand, had obtained measurements only from comparatively low altitudes, since their *sputniks* did not penetrate far enough into the zone of intense radiation as they crossed over the USSR. Due to its low perigee, however, the life of the third U.S. Army satellite was limited to three months.

In the meantime, the Navy was feverishly preparing a new *Vanguard booster (TV-5)*, which, with its large spherical satellite with a diameter of 20 in. and weighing 21.5 lb, was finally put onto the launching pad at Cape Canaveral on April 28th, 1959. But again the rocket failed, this time because of faults in the small electric ignition relays, which caused the third stage to fire prematurely and shot the instrument package, complete with X-ray detectors and solar battery, into the Atlantic Ocean.

After a six months' silence from the Soviet Union the world's press learned of the launching of a new earth satellite weighing 2,925 lb on May 15th, 1958. *Sputnik III*, a veritable space research laboratory containing dozens of measuring instruments weighing some 7,000 lb, is still circling the earth at an angle of 65.3 degrees to the equator. Its lifetime has been estimated at 15 months, and the results so far obtained have apparently exceeded all expectations. Carrying a magnetometer, a photomultiplier for recording the sun's corpuscular radiation, a mass spectrometer, photo recording equipment, an ionization manometer, electrostatic tension meters, special equipments for measuring radiation intensity at high altitudes etc., this third "Red Moon" yielded much new information on the earth's magnetic field, the composition of primary cosmic radiation, the distribution of photons, and heavy nuclei in cosmic radiation.

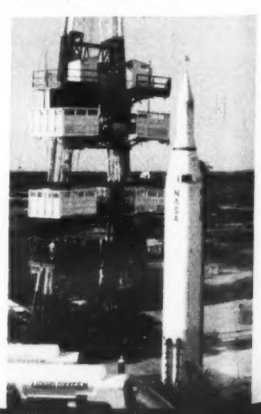
Name, country of origin, total orbit weight Wt payload weight Wp	Launching date and lifetime	Launching vehicle	Payload	Test Results P = perigee A = apogee
VANGUARD SLV-1 (USA) Wp = 21.5 lb.	May 27th, 1958 0	Vanguard three-stage rocket, similar to TV-3.	*Shape:* sphere; *diameter:* 20 in.; *shell:* as *Vanguard TV-5; instrumentation:* instrument for measuring solar Lyman-Alpha radiation; *transmitters, power supply and antennas:* as *Vanguard I.*	The ineffective cut-off of the second stage caused the third stage to climb too steeply, so that the desired orbit was not achieved. 20 minutes later the satellite and the final stage came down over the South African coast.
VANGUARD SLV-2 (USA) Wp = 21.5 lb.	June 26th, 1958 0	Vanguard three-stage rocket, similar to TV-3.	As *Vanguard TV-5*, except for a special instrument for measuring solar X rays.	Premature cut-off of second stage rocket motor.
EXPLORER IV (USA) Wt = 38.4 lb. Wp = 25.8 lb.	July 26th, 1958 approx. 1 year	As *Explorer I*	*Shape:* cylindrical, with conical nose: *length:* 80.39 in.; *diameter:* 6.25 in.; *shell:* stainless steel; *instrumentation:* 2 Geiger counters, two scintillation counters, temperature elements (connected to sub-carrier oscillator of transmitter).	Period 110.27 min; angle of trajectory 50.29°; further information on inner radiation belt. P = 163 miles A = 1,380 miles
LUNAR PROBE (USA) (no designation) Wt = 83.8 lb. Wp = 25 lb.	August 17th, 1958 0	*Thor/Able I* four-stage rocket; gross launching weight 112,000 lb.; height: 88.1 ft.	*Shape:* toroid; *diameter:* 29 in.; *shell:* fibreglass; *instrumentation:* radiation counters, magnetometer, instruments to measure micrometeorite density and temperature, electronic scanner for the moon; *transmitters:* 108.6 Mc/s (300 mW) for telemetry and Doppler signals, and 108.09 Mc/s (1 W); *power supply:* mercury batteries; *antennas:* two 12-in. whip antennas.	Engine failure in first stage after 77 sec.
EXPLORER V (USA) Wt = 38.43 lb. Wp = 25.8 lb.	August 24th, 1958 0	*Jupiter C* four-stage rocket.	*Shape:* cylindrical, with conical nose; *length:* 80 in.; *shell:* stainless steel; *instrumentation:* instruments for measuring corpuscular radiation at different levels of intensity; *transmitters:* 108.00 Mc/s (10 mW) and 108.03 Mc/s (30 mW); *power supply:* mercury batteries; *antennas:* two dipoles using satellite skin.	Successful launching; all stages fired. Due to residual thrust, however, the booster collided with the rotating drum of the upper stages and knocked them off course. Total flight time 659 sec.
VANGUARD SLV-3 (USA) Wp = 21.5 lb.	Sept. 26th 1958 0	*Vanguard* TV-3 three-stage rocket.	*Shape:* sphere; *dimensions and shell:* as *Vanguard* TV-5; *instrumentation:* two infra-red photo cells for cloud scan; *transmitters:* 108.00 Mc/s (10 mW) and 108.03 Mc/s (1 W); *power supply:* mercury batteries.	Second stage delivered inadequate thrust, so that the rest of the vehicle, which had apparently circled the earth once, re-entered the atmosphere.
PIONEER I (USA) Wt = 84.4 lb. (including verniers and retro-rockets) Wp = 39 lb.	Oct. 11th, 1958 to Oct. 12th, 1958 (43 hr 17.5 min)	*Thor/Able I* four-stage rocket.	*Shape, dimensions, shell, instrumentation and transmitter* as first lunar probe using *Thor/Able I.*	Insufficient launching speed; satellite re-entered the earth's atmosphere over the South Pacific after reaching a height of about 70,700 miles. Numerous measurements were taken.



Sputnik III.

Instrumentation package for the Pioneer I.

Juno II *carrier rocket for the* Pioneer IV *sun satellite.*



As the instruments are housed mainly in the nitrogen-filled inner chamber of the 11 ft long conical casing (where the temperature fluctuates between 62.6 and 69.6°F) a high degree of accuracy is to be expected. Furthermore, *Sputnik III* confirmed American measurements of the belt of radiation round the earth and proved that atomic oxygen and nitrogen are still to be found at heights of 150 to 400 miles.

In spite of certain changes in the U.S. Navy's *Vanguard* programme as a result of the early failures, subsequent attempts by the U.S. Naval Research Laboratory to launch satellites were also doomed to disaster. On May 27th and June 26th of the same year the two-stage motors of the SLV-1 and SLV-2 boosters failed, and in each case the precious instruments were lost. Later the SLV-3, the booster for a *Vanguard* meteorological observation satellite with two infra-red photo cells for cloud scan, launched on September 25th, 1958 plunged down somewhere over Central Africa after the failure of its second stage. Finally, another attempt made five months later with similar instrumentation met with success: The *Vanguard II*, launched on February 17th, 1959, transmitted cloud cover information for over twenty days and will circle the earth for about ten years.

The reasons for the many failures are without exception to be sought in the booster rockets. The *Vanguard* rocket was the only vehicle specially designed for satellite launchings, the other Western and Soviet boosters being variants of giant military rockets. Since only limited funds were available for the design of the non-military *Vanguard* rocket project, it was necessary to develop a relatively small motor with a light cell, an undertaking naturally attended with risks. Descriptions of the *Vanguard* rocket will be found in Interavia No. 12, 1957 and No. 12, 1956.

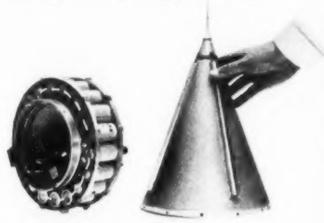
Meanwhile the U.S. Army was pushing ahead with preparations for fresh satellite launchings. The *Jupiter C* launching vehicle had given full satisfaction, and it was decided to launch a *fourth Explorer* on a trajectory at 50 degrees to the Equator. The orbits of the earlier U.S. satellites had formed an angle of only 33 degrees to the Equator, so that they covered a smaller area of the earth's surface than the Soviet satellites. As the components of the earth's rotation in the direction of launching are small in the case of a "steep" launching, the latter requires a greater total impulse; i.e., either higher thrust for the same burning duration, or the same thrust for a longer burning duration. *Explorer IV* has two Geiger counters and two scintillation counters to measure corpuscular radiation at various intensity levels. Its transmitter, which operated for roughly two months (on mercury batteries), again supplied valuable data on the radiation belt around the earth and provided new knowledge concerning the transmission of data from space. The fifth *Explorer* satellite failed to go into orbit, as under the influence of a residual thrust the booster *(Jupiter C)* collided with the rotating drum carrying the other three solid-propellant stages and threw them off the prescribed trajectory, despite the fact that all three ignited correctly.

*

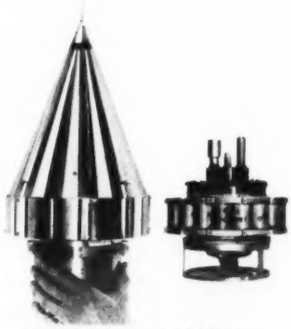
Soon the contest between the two astronautical Big Powers began to turn towards a new objective, which made even higher demands on rocket engineers and State coffers: to launch a successful moon probe. By August 1958 the USAF felt it was ready to make the attempt, with its four-stage *Thor-Able I* rocket (weight 112,000 lb). The ascent lasted just 77 seconds... and yet another dream was at an end. The *Thor* first stage exploded at the lower limit of the stratosphere.

The Air Force's next attempt, however, was somewhat more succesful. On October 11th of the same year its *Pioneer I* climbed to an altitude of about 70,700 statute miles, but it too fell back to earth after 43 hours. Nevertheless this momentous advance into space brought a wealth of highly interesting information, as the transmitter and instruments functioned throughout the expedition. Results: 1. the radial extent of the inner radiation band was determined, and it was found that the radiation discovered by *Explorer* occurs chiefly as an equatorial belt of cardioid pattern; 2. the ionizing flux was mapped along

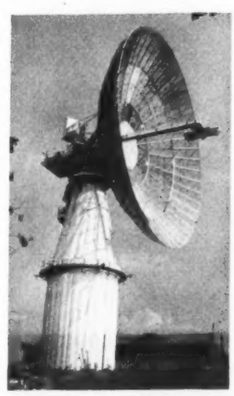
Name, country of origin, total orbit weight Wt payload weight Wp	Launching date and lifetime	Launching vehicle	Payload	Test Results P = perigee A = apogee
BEACON (USA) Wt = 31.5 lb. (inflatable sphere = 9.26 lb.)	Oct. 23rd, 1958 0	USAF *Jupiter C* four-stage rocket.	*Shape:* cylindrical shell containing balloon; *shell length:* 50 in.; *balloon composition:* polyester film and micro-thin aluminium foil; no instrumentation or transmitters; device for ejecting and inflating balloon.	The upper stages of the rocket and the inflatable satellite separated prematurely from the booster and fell to earth after 424 sec.
PIONEER II (USA) Wt = 86.4 lb. Wp = 34.3 lb.	Nov. 8th, 1958 0	*Thor/Able I* four-stage rocket.	*Shape, dimensions and shell:* as first lunar probe; *instrumentation:* instruments for measuring total ionizing radiation, cosmic ray flux, magnetic fields of earth and moon, micrometeorite density and internal temperature, with an electronic scanner for recording moon observations; *transmitters and power supply:* as *Pioneer I.*	Altitude reached 960 miles. As the third stage failed to ignite, *Pioneer II* re-entered the earth's atmosphere after 42.4 min. During this period, however, measurements showed that the intensity of the equatorial radiation belt is greater than originally believed.
PIONEER III (USA) Wp = 12.95 lb.	Dec. 6th, 1958 to Dec. 7th, 1958	U.S. Army *Juno II* four-stage rocket; gross launching weight 121,000 lb.	*Shape:* conical; *length:* 23 in.; *diameter:* 10 in.; *shell:* goldwashed fibreglass; *instrumentation:* cosmic ray measuring equipment; *transmitter:* 960.05 Mc/s (180 mW); *power supply:* mercury batteries.	Altitude reached 63,580 miles. *Pioneer III* discovered a second (outer) radiation belt round the earth, and came down over French Equatorial Africa after 38 hr.
ATLAS/SCORE (USA) Wt = 8,750 lb. Wp = 150 lb.	Dec. 18th, 1958 to Jan. 21st, 1959	USAF WS 107A-1 *Atlas* two-stage ICBM; gross launching weight 244,000 lb.; height 85 ft.	*Shape:* instruments were installed in the nose and in the bulges on the sides of the *Atlas; length of ICBM:* 85 ft.; *diameter:* 10 ft.; *instrumentation:* double set of transmitter/receivers with magnetic tape recorder and radio beacon. The experimental communications equipment operated on frequencies of 132.435 Mc/s and 132.905 Mc/s, the beacon on 107.97 and 107.94 Mc/s.	Initial period 101.46 min; angle of trajectory 32.3°. The experiment showed that it is possible to transmit spoken and coded messages from the ground to the satellite and vice versa.
LUNIK (MECHTA) (USSR) Wt = 3,245 lb. Wp = 796.5 lb.	Jan. 2nd, 1959 Indefinite	Not disclosed, but believed to be three-stage rocket with launching thrust of 580,000 lb.	*Shape:* sphere; *diameter:* about 40 in.; *shell:* pentagonal stainless steel strips and two hermetically sealed shells of aluminium alloy; *instrumentation:* equipments for – 1. measuring the moon's magnetic field; 2. measuring the intensity of cosmic radiation outside the earth's magnetic field and recording fluctuations in radiation; 3. measurement of photon level in cosmic rays; 4. investigation of possible lunar radioactivity; 5. investigation of heavy nuclei in cosmic rays; 6. investigation of gas traces in interplanetary matter; 7. investigation of the sun's corpuscular radiation; 8. determination of meteoric erosion; *transmitters:* 19.997 Mc/s, 19.995 Mc/s, 19.993 Mc/s, also a beacon transmitting special measurements on the 183.6 Mc/s range; duration of transmission a few days.	Period of rotation round the sun about 15 months; perihelion 90,970,000 miles; released sodium vapour to form a cosmic cloud which was to be tested as a possible radio reflector.



Pioneer III *space probe with battery set (left).*



Pioneer IV *solar satellite with battery and radiation measuring instruments (right).*



Antenna for the Millstone Hill, Massachusetts, satellite tracking station.

the path covered; 3. "hydromagnetic oscillations" in the earth's magnetic field were observed for the first time; 4. certain anomalies were discovered in the shape of the earth's magnetic field, compared with the theoretical predictions; 5. first measurements of micrometeorite density in interplanetary space were made; 6. first measurements were made of the interplanetary magnetic field.

USAF attempt number three, this time to send *Pioneer II* past the moon, also failed a bare hour after launching—the third stage of the *Thor-Able I* vehicle refused to ignite.

Next it was the turn of the U.S. Army. Once again, the launching of its first moon vehicle (*Pioneer III* with *Juno II* carrier rucket) can be described merely as a partial success. *Juno II*, which was mounted on a *Jupiter* IRBM, was unable to overcome the earth's gravity, despite the fact that it came within 3½ percent of the design terminal velocity of 24,897 m.p.h. *During its 38-hour journey in space, however, Pioneer III discovered the second radiation belt round the earth.*

Once again it was left to the Soviets to make the decisive advance towards the moon and sun. On January 2nd, 1959 a giant multi-stage rocket, with a thrust estimated by Pentagon circles to be more than 580,000 lb, was launched from an undisclosed point in the Soviet Union. The total weight of the planetoid, which is now in orbit around the sun, is given by Russian sources as 3,245 lb. Some 36 hours after launching the space vehicle passed by the moon at a speed of 1.53 miles/sec, reportedly at a distance of some 4,660 miles from the earth's natural satellite. For several days its transmitters, working on closely neighbouring frequences (19.997, 19.995 and 19.993 Mc/s), passed data on gas traces in space, on the earth's and the moon's magnetic fields, on heavy nuclei in cosmic radiation and other space phenomena to Soviet ground stations. Some details of the versatile measuring instrumentation which the *Mechta* carried on its trip round the sun are given in the accompanying table. Only once does the huge radio telescope at Jodrell Bank appear to have picked up signals from the Russian planetoid; otherwise the launching, of which the Russians had given no advanced notice, passed undetected by the West.

Finally, two months later, the fifth American space probe, the Army's *Pioneer IV*, was fully successful. Launched from Cape Canaveral, the conical instrumentation package (weight 13.4 lb) travelled past the moon and traversed the perihelion of its orbit round the sun on March 17th, at a distance of 91,700,000 miles from the sun. It thus achieved its primary object, namely an earth-moon trajectory, although burnout velocity was 188 m.p.h. below the planned value, and the photoelectric device designed to record the passage past the moon failed to operate. Owing to a minor trajectory error, the closest the probe got to the moon was 37,300 miles, instead of the 20,000 miles which would have been necessary to trigger the recording equipment. Considerable interest was aroused by the fact that American and British tracking stations succeeded in following the *Pioneer IV* for nearly four days out to a distance of 407,000 miles into space. The costly experiment of sending a probe to the moon and sun was in no sense a mere prestige achievement for the United States, but provided new details on radiation intensity in interplanetary space and on changes in the two radiation bands round the earth since the *Pioneer III* launching.

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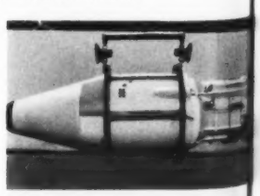
Pioneer IV was the last of five space probes launched during the International Geophysical Year to explore the further reaches of space, but was certainly not the only goal of the U.S. space research programme. Late last year, on December 18th, the Advanced Research Projects Agency undertook an interesting

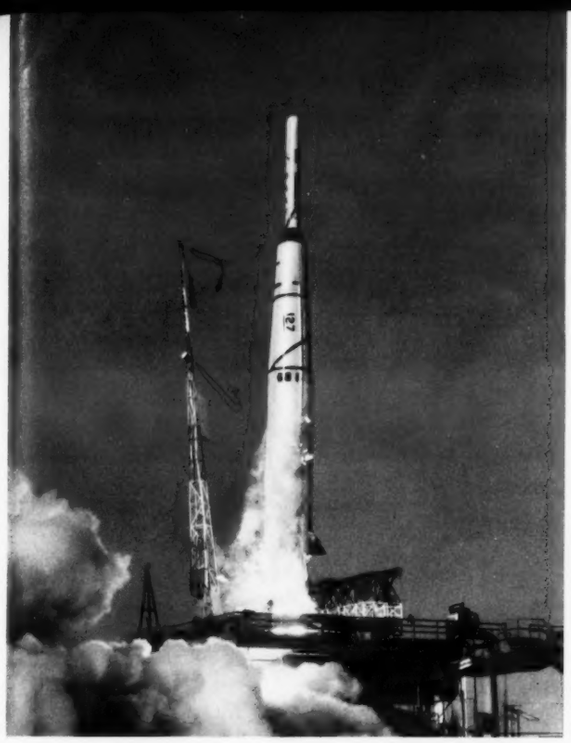
Name, country of origin, total orbit weight Wt payload weight Wp	Launching date and lifetime	Launching vehicle	Payload	Test Results P = perigee A = apogee
VANGUARD II (USA) Wp = 20.74 lb.	Feb. 17th, 1959 Over 10 years	*Vanguard* three-stage rocket, similar to TV-3.	*Shape:* sphere; *diameter:* 20 in.; *shell:* as *Vanguard* TV-5; *instrumentation:* infra-red photo cells for cloud scan; *transmitters:* 108.00 Mc/s (10 mW) and 108.03 Mc/s (80 mW), triggered from the ground; *power supply:* mercury batteries.	Period 125.85 min; angle of trajectory 32.88°; the experiment showed that satellites were basically suitable for overall weather observations, though it was difficult to evaluate the data because the satellite developed a wobbling motion.
PIONEER IV (USA) Wp = 13.4 lb.	March 3rd, 1959 Indefinite	*Juno II* four-stage rocket.	*Shape:* conical; *length:* 20 in.; *diameter:* 9 in.; *shell:* gold-washed fibreglass; *instrumentation:* radiation counters, photoelectric sensor in vicinity of moon; *transmitters:* 960.05 Mc/s at 180 mW with 3 sub-carriers; *duration of transmission:* approx. 90 hr.	Solar orbit; satellite arrived at perihelion, 91.7 million miles, on March 17th, 1959, and is scheduled to arrive at aphelion, 106.1 million miles, on October 1st this year.
DISCOVERER I (USA) Wt = 1,300 lb. Wp = 245 lb.	Feb. 28th, 1959 to March 5th, 1959	*Thor* single-stage booster with Bell *Hustler* rocket motor in satellite rear.	*Shape:* cylindrical, with conical nose: *length:* 19.2 ft.; *diameter:* 5 ft.; *instrumentation:* secret, but included horizon scanner for attitude stabilizer; *transmitters:* details secret, but included telemetry and tracking beacon.	Period 95.9 min; angle of trajectory 87°; the attitude stabilizer did not work properly, causing *Discoverer I* to wobble, so that its measurements could be recorded only intermittently. P = 99 miles A = 605 miles
DISCOVERER II (USA) Wt = 1,610 lb. Wp = 245 lb. + 195 lb. capsule	April 13th, 1959 to April 26th, 1959	As *Discoverer I*	*Shape and dimensions:* as *Discoverer I* but with hemispherical recovery capsule 33 in. in diameter in its nose; *instrumentation and transmitters:* classified (similar to *Discoverer I*); *power supply:* nickel cadmium batteries.	Period 90.5 min; angle of trajectory 88°; attempts to eject the capsule, which was to have been recovered in the region of Hawaii, were unsuccessful. It was later released by an automatic switch and is believed to have come down near Spitzbergen on April 14th. P = 142 miles A = 220 miles
VANGUARD Two Satellites IIIA and IIIB (USA) Wp = 23.3 lb.	April 13th, 1959 0	*Vanguard* SLV-5 three-stage rocket.	*Shape, dimensions and shell: Vanguard IIIA* – plastic sphere 13 in. in diameter with cylinder extending from it; *Vanguard IIIB* – inflatable plastic balloon covered with aluminium foil; *instrumentation: Vanguard IIIA* – magnetometer; *Vanguard IIIB* – none (designed for optical tracking to determine gas density at the edge of the atmosphere); *transmitters: (Vanguard IIIA)* – 108 Mc/s (10 mW) and 108.03 Mc/s (80 mW), the latter for transmission of data when triggered from the ground; *power supply:* silver zinc batteries.	The second stage fired too late and caused a tumbling motion which brought the two satellites down after 500 sec flight.
DISCOVERER III (USA) Wt = approx. 1,600 lb. Wp = approx. 240 lb. + 160 lb. recovery capsule	June 3rd, 1959 0	As *Discoverer I*	*Shape, dimensions, shell* etc.: As *Discoverers I* and *II*, except for the recovery capsule, which contained four live mice.	It was intended to put the satellite into a polar orbit, but faulty adjustment of the second stage brought it down prematurely.
DISCOVERER IV (USA)	June 1959 0	As *Discoverer I*	Not disclosed.	Did not reach the required orbital velocity due to failure of the second stage, and fell back.

Atlas/Score *satellite rocket with radio equipment for the transmission of messages from space.*

Discoverer *satellite with* Thor *booster rocket.*

Discoverer I: *the tail (right) carried the Bell rocket motor.*





Launching a *Thor-Able* carrier rocket with *Pioneer* space probe.

experiment in an entirely new development direction: use of space vehicles as relay stations for radio communications purposes. Under project *Score* the USAF fired a complete WS-107A-1 *Atlas* intercontinental ballistic missile, with modified nose cone, into a satellite orbit and for twelve days used it for the following radio experiments. Two satellite stations with magnetic tape storage system continuously received spoken or keyed coded messages from ground stations in Texas, Arizona and Georgia and retransmitted them later on 132.435 and 132.905 Mc/s to a number of ground receivers. Minitrack stations on the ground tracked the *Atlas* satellite with the aid of signals from its other transmitter, which worked on 107.97 and 107.94 Mc/s. This experiment proved not only that satellites can be used for telecommunications tasks, but also that very considerable weights can be placed in orbit by the booster engines of modern ICBMs. The empty *Atlas* airframe, complete with cruise power unit and instrumentation, weighed 8,750 lb, a figure which, on the other hand, appears less impressive when it is realized that the payload container was 85 ft long and that the gross launching weight of the vehicle was about 244,000 lb.

Parallel to these experiments the USAF's Ballistic Missile Division was working (under contract to ARPA) on a comprehensive military satellite programme which became known to the public as project *Discoverer*. This programme was based on studies made by the Rand Corporation in 1946, but did not take final shape until 1956, when Lockheed—as the USAF's present main contractor—received the green light for the development of a series of *Discoverer* space vehicles. The cylindrical satellites, launched by a modified *Thor* rocket, are equipped with a Bell liquid-propellant engine which makes final course corrections and accelerates the half-ton package along a horizontal trajectory up to orbital velocity.

The first two *Discoverers* were sent up in a north-south direction from Vandenberg, California, and guided into a trans-polar orbit on which they covered the whole face of the globe in a period of 12 hours.

All the *Discoverer* satellites have an attitude stabilizing system, including a horizon scanner and vernier control. On the first experiment, however, this system did not work entirely satisfactorily, and both radio tracking and data transmission were defective. Whereas *Discoverer I* was used solely to test the powerplant, guidance and stabilizing systems and the radio installation, the second *Discoverer* carried a jettisonable capsule which was to have been released by a signal from the ground, retarded by a retro-rocket, brought down into denser layers of the atmosphere and then recovered by special aircraft in the Hawaiian area. However, owing to an error in the timing mechanism for the capsule release, this programme could not be completed. On June 3rd ARPA and USAF launched another *Discoverer,* this time carrying several mice in a recoverable capsule. This experiment also failed, as the satellite did not even reach its planned orbit. *Discoverer IV* likewise failed because it did not attain the required orbital velocity. The Pentagon has recently revised the *Discoverer* programme, but retained the same objectives, namely to investigate the environmental conditions for space travellers, test recovery systems for satellites, check military satellite equipment and television cameras, radio communications equipment, etc. The whole programme is eventually to lead to the WS-117L *Sentry* observation satellite, which has also been worked out by Lockheed.

Mention should also be made here of yet another American experiment, which was planned for October 1958 under project designation *Beacon*... and which also failed. A *Jupiter C* was to have carried an inflatable balloon satellite on to a severely eccentric elliptical orbit. The *Beacon* had a large frontal area and low weight and was designed to provide more accurate information on gas density at the edge of the ionosphere and exosphere (by measuring their braking effect). However, the final stage of the carrier rocket separated prematurely from the booster and dived into the Atlantic, which had already swallowed up dozens of other stray satellites.

At the time of writing the United States is preparing to launch the roughly 142-lb *Explorer VI* research satellite, which will carry a wide variety of instruments and complete the investigations originally planned for the unsuccessful *Vanguard* launchings. These instruments will include radiation and heat balance detectors (a similar set of instruments was aboard the last *Vanguard* satellite), X-ray and ultraviolet ray detectors, supplied by Dr. Herbert Friedmann (again similar to instruments lost in two unsuccessful *Vanguards)*, a detector for cosmic radiation by Dr. James Van Allen, a special measuring chamber to investigate heavy nuclei in cosmic radiation, and two solar-powered transmitters on frequencies of 20 Mc/s and 108 Mc/s, to measure the absorption of radio signals by the atmosphere.

The satellite will also contain a device to switch off the transmitter after one year's operation. The cells in the solar battery will charge an accumulator to supply current to the transmitter and measuring instruments. As the solar cells will be unprotected against the impact of micrometeorites, it should be possible to determine the density of meteorites from changes in transmitter power due to the destruction of individual cells.

Still more ambitious projects are awaiting execution in the secret files of NASA and ARPA, including the top-priority "man-in-space" programme for the *Mercury* satellite capsule.

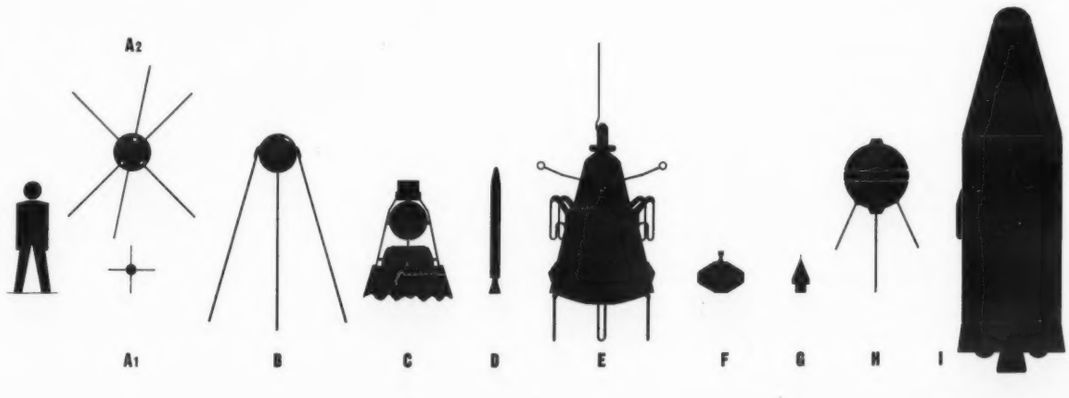
*

It is now some 350 years since astronomer Johannes Kepler discovered and gave his name to the laws of motion of the planets, which also govern the behaviour of artificial planetoids. Two years ago a small metal sphere circled the earth for the first time, and since that date the chroniclers have recorded more than thirty successful or unsuccessful space launchings. In another few years—or perhaps even months—large military satellites weighing several tons and manned space vehicles will be appearing on the front pages of the daily newspapers. Legal experts will elaborate new regulations for traffic in space, and politicians will have to familiarize themselves with the idea of using artificial heavenly bodies to check observance of military agreements.

The book of the twentieth century is still only half written; the second half lies... in the stars.

The silhouettes (scale 1:100) show the comparative sizes of the following satellites:

A1 – *Vanguard I* miniature satellite;
A2 – Large *Vanguard* satellite (TV-5);
B – *Sputnik I;*
C – *Sputnik II* with part of the final rocket stage;
D – *Explorer I;*
E – *Sputnik III;*
F – *Pioneer I;*
G – *Pioneer IV;*
H – *Lunik;*
I – *Discoverer II.*

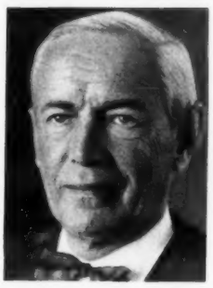


What's in the Air?

● **In July Scandinavian Airlines System** opened a *Caravelle* service on the Copenhagen–Düsseldorf–Geneva–Rome–Athens–Beirut-Teheran route, leaving Copenhagen every Monday and Friday, and Teheran every Tuesday and Saturday. SAS's *Caravelle* service now touches 22 points in Europe, the Middle East and Africa.

● **Air France** introduced the *Caravelle* into regular daily service Paris–London and London–Nice at the end of July. It leaves Paris at 08.00 hours each morning for London, and leaves London at 10.20 hours for Nice; scheduled flight time London–Nice is 1 hour 45 minutes. The return flight departs Nice 14.00 hours for London, and London 18.00 hours for Paris. The flights are operated in association with British European Airways.

Flight engineer Ebbe Ernstgard of Scandinavian Airlines System became the thousandth pupil to be familiarized with the DC-8 at Douglas Aircraft Company's Lawnsdale Service Training Department. Courses began in October 1957 and last from eight days to six weeks according to task.



Left: Professor Dr. Georg Madelung, President of the Arbeits- und Forschungsgemeinschaft Graf Zeppelin (Graf Zeppelin Research Association), celebrated his seventieth birthday on July 31st. In 1912 he was one of the founders of the Wissenschaftliche Gesellschaft für Flugtechnik, now the Wissenschaftliche Gesellschaft für Luftfahrt, and in 1914 joined the Deutsche Versuchsanstalt für Luftfahrt, to whose Board he was appointed in 1926. After World War II he went to the USA to investigate the capacity of the human body to withstand high rates of acceleration and deceleration, and from 1954 to 1957 taught at the Technische Hochschule, Stuttgart.

Right: The well-known German sports flyer Wolf Hirth was killed in a gliding accident near Dettingen/Teck on July 25th; he was 59 years old. In 1934 he set a world record for free flight in his Moazagotl *high-performance sailplane. He trained many pilots in high performance flight at the Grunau/Riesengebirge and Hornberg/Württemberg gliding schools. Of his sailplanes, the* Minimoa *and the* Goevier *were the most popular, both in Germany and abroad, and his work and writing contributed substantially to the progress of sports flying throughout the world. After World War II he became the first President of the new German Aero Club.*

● **Slick Airways Inc.**, the Californian all-cargo carrier, has placed an initial order for six Lockheed *Super Hercules* turboprop air freighters at an approximate cost of $22 million; the first *Super Hercules* is scheduled to go into operation in early 1962. Slick plans a fleet of eleven *Super Hercules*, which it estimates will carry annually almost twice the amount of cargo carried by the whole U.S. domestic air freight industry in 1958.

● **The U.S. Federal Aviation Agency** has proposed to the U.S. airlines that all passenger aircraft be fitted with storm warning radar; it pointed to the excellent safety record of airlines using such equipment. United Air Lines, which pioneered radar in 1954, said that it saves over half a million dollars annually in hail damage and structural strain. About 60 percent of scheduled carriers' 1,500 aircraft carry radar. The Air Transport Association estimates equipment costs at about $20,000 per aircraft.

● **The air cargo** handled at Frankfurt's Rhein/Main airport during the first six months of 1959 showed a 52.6 percent increase over that handled in the corresponding period in 1958; air cargo arriving from abroad increased by 71.8 percent.

● **Elipadana, Società Alta Italia Trasporti Elicotteri**, has been formed at Milan with a capital of 20 million lire: the company's President is Agostino Giambelli. The following services are to be operated: Milan–Turin, Milan–Genoa–San Remo, Milan–Malpensa Airport-Lugano and Milan–Verona. At the beginning of August Elipadana made route proving flights with the Sikorsky S-62 turbine-powered helicopter.

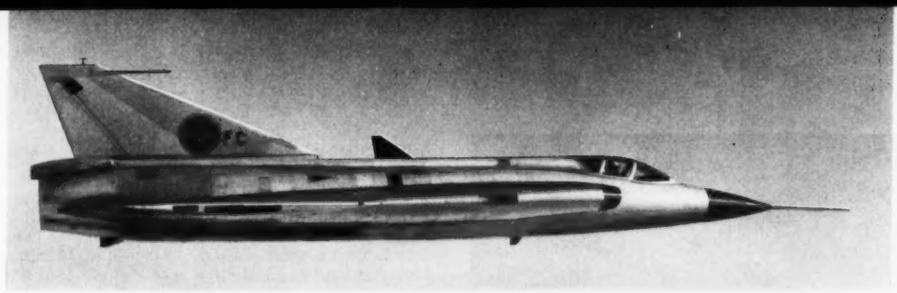
● **The British Minister of Transport and Civil Aviation,** Harold Watkinson, has announced the Government's decision to establish an Air Traffic Control Board. This organization, which will be responsible to both the Secretary of State for Air and the Minister of Transport and Civil Aviation, will formulate U.K. policy and coordinate the work of all U.K. authorities concerned with air traffic control matters. The chairman of the Board will be independent, and its members drawn from the Ministry of Transport and Civil Aviation, the Air Ministry, the Admiralty and the Ministry of Supply.

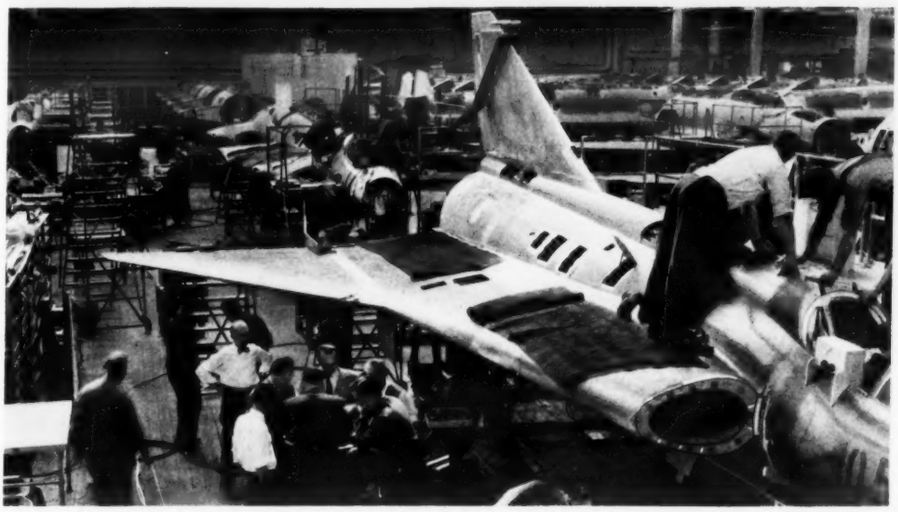
● **The Firestone Tire & Rubber Company** has given the California Institute of Technology $1,050,000 for the construction of a new aeronautics laboratory. To be known as the Firestone Aeronautical Research Laboratory, the new facility will be devoted chiefly to studies of missile and aircraft structures at hypersonic speeds, flow problems at hypersonic speeds such as those experienced by vehicles operating within or passing through the earth's atmosphere, and heat transfer, including melting of surfaces exposed to hypersonic gas streams. Among the installations will be wind tunnels operating at speeds up to 12,400 m.p.h., plasma jets and shock tubes.

● **The Douglas Aircraft Company** reported a loss of $15,010,000 for the first half of the current fiscal year ended May 31st, as against a profit of $12,645,000 or $3.31 per share for the corresponding period last year. The loss was accounted for by research and development costs of the DC-8, amounting to $17,730,000. As further expenditure is expected in connection with the DC-8 programme, there are also likely to be losses in the second half of the year.

● **VEB Flugzeugwerke Dresden,** which has so far produced 75 Ilyushin Il-14Ps, has received an order from the People's Republic of China for the supply of a further large batch of aircraft. The first aircraft to be supplied under the new order have already been flown by VEB Dresden personnel to Peking, via Moscow, Sverdlovsk, Novosibirsk and Irkutsk. The fourth pre-

Dassault Mirage III A *single-seat fighter (SNECMA* Atar 9 *plus SEPR auxiliary rocket motor). Six* Mirage III As *are being flight tested, the last two being equipped with the new* Cyrano *radar.*





Saab-35A Draken *single-seat fighter, in quantity production at Svenska Aeroplan AB, Linköping.*

production model of the Type 152 jet aircraft will begin ground tests by October 31st, instead of December 31st as originally planned. — By 1965 it is intended to raise the firm's productivity to 250 percent of present output by introducing shift work and transferring the machinery now in the laboratories to the production programme. — Works manager A. Rentsch was recently relieved of his post. His successor is Werner Niemand, for many years a skilled aircraft toolmaker, then an engineer and later a manager in the wing construction division. Since the beginning of 1959 he has been Chairman of VEB Flugzeugwerke's Economic Committee.

● **The Daily Mail Blériot Anniversary Race** was won by Squadron Leader Charles Maughan, RAF, whose total time from the Arc de Triomphe, Paris, to Marble Arch, London, was 40 minutes 44 seconds. Second prize was won by Skyways Managing Director Eric Rylands, in 41 minutes 41 seconds. Both used helicopters and jet aircraft. The special prize for originality was won by a BEA team, who used existing facilities but cut the normal London–Paris travel time by over two-thirds.

● **The Dassault Mirage IVA bomber** (SNECMA *Atar 9*) has completed its whole series of tests just one month after its first flight. It reached a speed of Mach 1.9 on its fourteenth flight. — The *Etendard IVM-05 (Atar 8)*, one of the pre-production models, made its first flight at Mérignac on July 4th. A version with Rolls-Royce *Avon* jet and boundary layer control is now being assembled and is scheduled to make its first flight towards the end of October. Four aircraft are being used for the test programme on the *Etendard IV Marine*, and armament tests are due to begin in September.

Meanwhile, six *Mirage IIIs (Atar 9)* are undergoing tests, the last two of them equipped with the new *Cyrano* radar. Tests on aircraft No. 2, using a SEPR auxiliary rocket engine, have been speeded up, and an altitude of 67,250 ft has been reached at Mach 1.8.

● **Société Breguet** is developing, in cooperation with the Secretariat General of Civil and Commercial Aviation, a version of the Breguet 941 with pressure cabin. The fuselage of the present version would reportedly be replaced by a fuselage of circular section with cabin space for 50 passengers.

The Northrop N-156F Freedom Fighter *(2 General Electric J85 with afterburners) began flight tests on July 30th. The picture shows last-minute preparations for the N-156's maiden flight at the USAF's Edwards Air Force Base, California. In the background are two Northrop T-38 Talon two-seat trainers which have been undergoing tests at Edwards for some time.*

● **Some interesting facts on North American Aviation's B-70 Valkyrie Mach 3 bomber** and F-108 *Rapier* long-range interceptor are revealed by *Interavia's* correspondent in Los Angeles. These aircraft are now under development for the USAF and are designed to serve as missile platforms under the "mixed force concept" (combination of aircraft and missiles).

The four-seat, six-jet B-70 is expected to be 170 ft long with a wing span of 115 ft, and weighing some 500,000 lb; the two-seat F-180 *Rapier* will feature a length of about 68 ft, a span of approximately 46 ft and a gross weight of roughly 100,000 lb. Both aircraft will be powered by General Electric J93 jet engines fitted with afterburners and developing more than 25,000 lb of thrust.

The operating technique for the B-70 and F-108 is worthy of brief mention. Unlike existing models, the aircraft will be able to fly all their missions at maximum speed. Thus the *Rapier* will fly over 1,000 miles at Mach 3, fulfil its mission and return 1,000 miles to base again at Mach 3. Similarly, the B-70 *Valkyrie* will be able to cover 3,000 to 4,000 miles at Mach 3 and at an altitude of 70,000/75,000 ft, and return to home base at the same altitude and speed after accomplishing its mission.

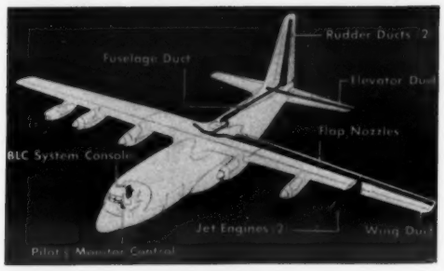
Neither of the two aircraft will carry defensive weapons. As its primary offensive weapon, the B-70 will carry the 10-megaton hydrogen bomb, together with ALBM's (Air Launched Ballistic Missiles). The F-108 will be armed with three Hughes GAR-9 missiles.

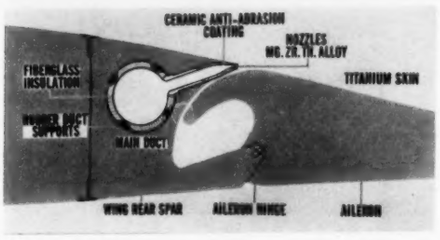
The first Boeing 707-420 (four Rolls-Royce Conways*) for British Overseas Airways Corporation interrupted its FAA certification test flights to take part in the flight display at the celebrations in Vancouver, British Columbia, to mark the Golden Jubilee of Aviation in Canada. The picture shows it standing next to a model of the 1912 Curtiss biplane built and flown by Boeing flight test engineer Pete Bowers.*

The B-70 will require an estimated 14.5 million engineering manhours. It is not expected to be in the air before mid-1961, but the F-108 will roll out early next year.

● **Folland,** in considering a long-term programme for the *Gnat*, is working on a new 5 percent thickness wing of 150 to 160 sq. ft, which could eventually be used for both trainer and fighter variants. The Mark 2 fighter would have a speed of Mach 1.5 and would carry advanced A.I. radar and air-to-air weapons (probably *Sidewinder)* or unguided air-to-air rockets. The engine would be an uprated *Orpheus* (not the BOr. 12 however) with either a Bristol Siddeley or a Swedish afterburner. The Mark 2 trainer would be capable of Mach 1.5 at 35,000 ft and climb to 50,000 ft

The Fairey Rotodyne *has been demonstrated to British services and ministry officials as a flying crane. After a three-mile flight it laid a 103-foot bridge at the exact location required. The military version of the* Rotodyne *can transport loads of about 20,000 lb at speeds up to 200 m.p.h.*





The provisional designation for the new Lockheed Hercules *military transport fitted with a boundary layer control system is C-130C. An experimental STOL* Hercules *is being built for the USAF at Lockheed's Marietta, Georgia, division. Top: schematic conception of the BLC system, showing wing and empennage surfaces over which will be led bleed air from two small modified jet engines housed in auxiliary pods under each wing. This will improve short take-off and landing characteristics and ensure rudder and elevator effectiveness during low speed. Bottom: schematic cross-section of a main duct installation in the C-130's wing. Fibreglass is used to insulate the duct, and titanium skin is required on the ailerons.*

Yugoslavia's Fabrika Aviona Utva-Pancevo announced that a new multipurpose four-seater aircraft, the Utva-56, has begun flight testing. This all-metal strutted high-wing monoplane, designed by Branislav Nikolić and Dragoslav Petković, is powered by a 260 h.p. Lycoming GO-435-C2B2 engine. Span is 37.4 ft, wing area 194.6 sq. ft, gross weight 2,840 lb, cruising speed 124 knots, take-off and landing distance 490 and 640 ft, range 380 n.m., service ceiling 19,680 ft.

with reheat in 3.1 minutes; landing speed would be 105 knots; range 800 miles with external tanks; all-up weight 7,910 lb. — Folland is also working on a naval version of the Mark 2.

● **Hawker Hunters** to be equipped for ground-attack duties at overseas bases like Aden will receive the designation *Hunter FGA.9*. These aircraft will replace *Venoms* at present in use.

● **Avco Corporation's Lycoming Division** has announced the development of a 960 s.h.p. version of the T53 helicopter engine, now rated at 860 s.h.p. The new engine carries the designation T53-L-5 and will feature a reduction in weight with an improvement in specific fuel consumption.

● **Two Boeing QB-47 drones**, a conversion of the B-47, have been flight tested at the Air Proving Ground Center, Eglin AFB, Florida. The conversion was carried out by Lockheed's Georgia Division, and the Sperry Gyroscope Co. developed and constructed the guidance and control systems.

● **Aerojet-General** has been awarded a U.S. Army contract for design improvements, additional testing and manufacture of AN/USD-2 surveillance drones. The contract covers approximately $2 million and calls for further flight testing of two SD-2 drone systems early in 1960. The first SD-2 drones were developed and manufactured by the Defense and Technical Products Division of Rheem Manufacturing Co., which was recently purchased by Aerojet-General.

● **The latest mark** of the Gloster all-weather *Javelin* fighter is the FAW.9.

● **It is rumoured in London** that the RAF may get a high altitude Mach 3 + bomber as well as the TSR.2 for low altitude work. No requirement has yet been issued, but a number of the larger design teams in the United Kingdom have been working privately on such a project. It is also rumoured that Britain and the USA might collaborate on a very long endurance, atomic-powered bomber.

● **The Jodel DR.100 Ambassadeur** three-to-four seat sports and touring aircraft, experimentally fitted with the new 90 h.p. Potez 4E engine, has been awarded its type certificate. The engine had proved its worth during a large number of international rallies in which this model of the DR.100 took part. The 4E-powered *Ambassadeur* has now been certificated for a gross weight of 1,630 lb using a fixed-pitch wooden propeller, or 1,650 lb with a variable-pitch metal propeller. Until the 4E engine is available in quantity the DR.100 will be fitted with a 100 h.p. Continental engine. Quantity production of this version will begin on October 1st, 1959.

● **At the recent Paris Air Show** SFERMA demonstrated in flight two aircraft converted to turboprop operation at its plant: the Beech PD.18 (two Turboméca *Bastans)* and the Max Holste MH.153 (one Turboméca *Astazou)*. A Nord 1100, also converted to an *Astazou,* has recently been completed; it is now undergoing vibration tests, and flight testing is due to begin in a few weeks' time.

● **The Armstrong Whitworth Argosy** had made over 216 test flights by the middle of August, only three of which were delayed for unserviceability. By that date five had flown of the initial ten and the remaining five were coming off at the rate of one per month; 350 hours of flying, i.e. approximately one third of the complete instrumented test programme, had been logged. The full Certificate of Airworthiness programme to British and American standards should be completed by March 1960—two months ahead of the original schedule.

The second *Argosy* will be used this month and next month for tropical trials at Khartoum, covering 200 hours flying; this test phase will be followed by cold weather trials.

Structural testing of the *Argosy* has been an extensive programme with work being done both at Armstrong Whitworth Aircraft, Coventry, and A.V. Roe, Manchester. The complete fatigue test programme in the water tanks will simulate about 150,000 hours flying.

On the sales side, A.W.A. says that the majority of the first ten aircraft are the subject of negotiations and estimates that 40 or more civil *Argosy* aircraft should be sold in the next twelve months. On August 5th the *Argosy* was demonstrated at London Airport to senior officials of BEA, who is known to be interested in the type as a DC-3 freighter replacement. It is possible that BEA might lease or borrow an *Argosy* for route trials, as in the case of the *Dart Herald.*

The initial military contract for the AW.660 *Argosy* with "beaver tail" etc. is due to be signed within the next few weeks, and the first RAF *Argosy* should be off the line towards the end of 1960.

A Piaggio P.136L-2 five-seat amphibian (two 340 h.p. Lycoming GSO-480), belonging to the Greek shipowner A.S. Onassis, has been certificated in Switzerland and is now stationed at Geneva-Cointrin airport.

René Lucien, President and Managing Director of Etablissements Messier, has been made a Commander of the Legion of Honour.

From Moscow to New York by Tu-114

by Captain A. P. Yakimov, Aeroflot, Moscow

Meticulous preparations were made for the start of the Tu-114's first Moscow-New York non-stop flight. Navigator Konstantin Ivanovitch Malkhasian and I worked out flight routes and studied weather forecasts, and after exhaustive discussion a route was chosen from Moscow via Riga, Stockholm, Oslo, Bergen, Keflavik (Iceland) along the North American coast to New York.

Then came the great day: June 28th, 1959. The giant Tu-114 almost completely filled the apron in front of the terminal building at Vnukovo. Shortly before seven in the morning the first passengers began to arrive, on their way to the opening of the Soviet Exhibition of Science, Technology and Culture in New York. Among them was F. R. Kozlov, Deputy Prime Minister of the USSR.

As take-off time drew near, we started up the powerful propeller turbines and taxied onto the runway.

At 07 : 07 hours (Moscow time) our Tu-114 became airborne and headed northwest at an altitude of 30,000 feet. Barely an hour and a half later we could see beneath us the leaden waves of the Baltic, which we crossed in less than thirty minutes. Seen from far above, it was like an enormous river, the banks formed by its shores.

We were across the Scandinavian peninsula in less than 59 minutes, our last landmark being the port of Bergen in northern Norway, which we passed over at 10 : 05 hours Moscow time.

At that time the weather was good, but foreign radio stations reported dense layers of cloud ahead, coming down as low as 450 feet above the ground at New York.

But we were not in the least concerned, for we had excellent navigation instruments and radar to enable us to fly and land under the most difficult weather conditions. According to our calculations, we were due at New York at 11 : 00 hours local time or 18 : 00 hours Moscow time.

Over the North Atlantic the rocky Faroes were already behind us, and the Icelandic coast soon came in sight. We climbed to 33,000 feet to avoid the high cloud-banks in our path. At 12 : 00 hours, 4 hours 53 minutes after take-off, we passed Keflavik and headed for Newfoundland, where we were escorted by two American fighters which stayed with us for a few minutes before disappearing among the clouds.

We were already in our sixth hour of flight, and more than half the route lay behind us. Navigators Malkhasian and Solyanov had worked out the route so that we passed the check points to within ±1 to 5 minutes of scheduled time.

We heard the radio call sign from Gander, Newfoundland, and began to climb again. Below us lay a dense mass of grey cloud. Quite unexpectedly a Convair F-102 appeared on its surface and flew along close to our port side. Then it crossed to starboard, and, after the pilot had satisfied his curiosity, disappeared again into the cloud.

The instruments told us that every part of our mighty aircraft was working properly. Now and then General Andrei Nikolaevitch Tupolev, designer of the Tu-114, would come onto the flight deck and examine the instruments, taking a keen interest in engine behaviour, navigation equipment and fuel consumption. His face breaking into a smile, Andrei Nikolaevitch would joke with the crew: " Well, comrades, if the Americans won't let us land because of the bad weather, we can always turn round and go home ".

By that time we had been ten hours in the air, and Idlewild Airport reported no improvement in the weather situation. We descended and entered a blanket of cloud. Pilot Ivan Korneevitch Vedernikov and I anxiously followed the altimeter needles, and Navigator Malkhasian never once took his eyes from the radar screen.

We read 6,000 ft, 3,000 ft, 1,500 ft, 1,000 ft, 300 ft and finally 150 ft, but still there was no sign of the ground. We made a GCA landing, receiving continuous instructions from the ground to alter height and course. These were first given in English by an American GCA operator from our radar echoes, then radioed to us by a Russian-speaking pilot. These " second-hand " directions naturally led to certain delays in execution, and when we came out of the cloud at 100 feet we realized that it was too late to land. We flew across the runway with undercarriage down and turned right-about back into the clouds. At our second attempt we found the exact beginning of the runway and touched down.

We were separated from Moscow by 11 hours 6 minutes of non-stop flight and a distance of about 5,000 miles.

5,000 Visitors a Day

Once on American soil, with entry formalities completed, we were surrounded by American pilots and correspondents. Cameras clicked, and the first questions were asked.

The area where the Tu-114 was displayed became an overflow from the Soviet exhibition at the Coliseum. From ten in the morning to four in the afternoon a long queue was to be seen in front of our giant aircraft, and more and more visitors flocked in from New York and other cities. About 5,000 people filed past the Tu-114 daily.

Over and over again visitors told my crew—Navigator Konstantin Ivanovitch Malkhasian, Flight Engineer Leonid Alexeevitch Sabaluyev, Pilots Mikhail Alexandrovitch Nyukhtikov, Ivan Korneevitch Vedernikov, Konstantin Petrovitch Sapelkin—how impressed they were by the Tu-114's enormous size.

Most interest was shown by the pilots, navigators and technical staff of American and European air transport companies. Pilots just landed at Idlewild came aboard with their crews, questioned us about flying qualities and technical characteristics and asked to see the flight deck and navigation instruments. I opened the door to the flight deck and invited the nearest crew in.

We who are accustomed to the roomy Tu-114 with its well-arranged seating were amused to see the pilots creeping gingerly through the door one by one. How surprised they were to see that there was room for the entire crew and a few visitors into the bargain. Even the sceptics, for sceptics there are, could not help admiring the size and comfort of the flight deck and the completeness of the navigation instruments. All

were impressed by the large dials of the navigation equipment and the great number of engine controls.

Our guests' surprise is explained by the fact that, according to Pan American and Eastern Airlines pilots, the flight deck is cramped and the instruments are small even in the most recent types of American commercial aircraft. This, of course, makes the crew's work more difficult.

The stream of American visitors to our Tu-114 at Idlewild continued in full spate. Interest was shown not only in the flight deck and the navigation instruments, but also in the relatively small but high-powered engines, the gigantic contra-rotating propellers, swept wings, undercarriage and tail unit. The whole of our aircraft was carefully examined and photographed " full face and in profile ". The American press devoted a great deal of attention to the Soviet airliner and published accounts of it under striking headlines.

Most articles dealt objectively with the excellent qualities of the Soviet Tu-104B, Il-18, An-10 and Tu-114 passenger aircraft. The Russians were called pioneers in aircraft construction, the talent of the leading Soviet designers was praised, and Soviet aeronautical progress was impartially reported.

Our Impressions

Most cordial relations were established between many American pilots and ourselves. We told our American colleagues of our experience with Soviet turboprop and jet passenger aircraft, and they introduced us to their latest aircraft. We also made friends with the airport employees, who showed us round Idlewild.

Our crew had the chance to familiarize themselves with American aviation techniques not only on the ground, but also in the air. One day we were showing another group of American visitors over the Tu-114, when some pilots from Pan American came along: " Captain," said one of them to me, " Would you like to fly in our new jet aircraft, the Boeing 707 ? "

We eagerly accepted the proposal and chose July 9th for the flight. Early in the morning the Boeing 707's captain came to fetch us, and we were soon climbing aboard. It turned out that we were taking part in a check flight to test three American pilots familiarizing themselves with this aircraft. Konstantin Petrovitch Sapelkin and I were invited onto the flight deck, where we had the opportunity to watch the take-off, climb, turning, level flight and landing performance of the Boeing 707.

During the second flight the captain invited me to take the chief pilot's seat and handed me the joystick. I piloted the aircraft for 10 to 15 minutes in level flight, made a few turns and tried it out in glide and climb.

We were also shown the Lockheed *Electra* turboprop aircraft and were struck by the extensive use of plastics in the passenger cabin fittings. We were likewise impressed by the excellent reproduction quality of the passenger announcement system.

In their new aircraft, too, the Americans have not departed from the principle of making everything yield a profit. In order to obtain the maximum number of passenger seats the designers have greatly restricted the space in the flight deck, which is cramped, stuffy and difficult to turn round in.

When the American pilot got up from his seat during the Boeing 707 check flight, his shirt was wet with perspiration. I too felt very hot. Out of habit I tried to open the ventilator, as I do in the Tu-114, but I could find none in the Boeing. I cannot understand why American pilots are denied even such elementary comforts as these.

We Fly Home

Our brief stay was coming to an end, and we were due to fly home on July 13th, at four o'clock in the morning.

At two o'clock we went to the control tower to find out the weather situation around the airport and along the route. Also listening to the weather report were our four escorts: three Americans—a pilot, a navigator and a radio operator—and a Canadian navigator who was to accompany us by order of the Canadian Government. This arrangement was introduced as the result of an emergency landing made in Canadian territory when the aircraft carrying Deputy Prime Minister Mikoyan was returning to Europe. The navigator is authorized to report the Tu-114 for landing at any Canadian airfield.

Then we went to the aircraft, and the crew took their places as I made another personal check-up. It was nearly four o'clock, and before us lay the brilliantly lit runways, along one of which we were to take off over the sea, for it is forbidden to take off over the city at night. The peace of this noisy city must not be disturbed !

(At 04:22 hours local time (11:22 hours Moscow time) the aircraft left the runway. At 600 feet we entered the clouds, turned right-about and made for home.)

Looking round the flight deck, I could see Konstantin Ivanovitch Malkhasian and the Canadian navigator leaning over the charts at the navigator's station. Flight Engineer Sabaluyev was reading the instruments and keeping an eye on the engines. Engineer Aram Martynovitch Ter-Akopian was checking flight regime and fuel consumption against the flight schedule.

And what were our passengers doing? I went through the cabins and lounges. You could hear a pin drop. All were asleep, both great and small. I say small, for among our passengers was a one-year-old boy; in his sleep he had laid his little hands to one side, and his blanket had slipped off. Sleep was just as comfortable 30,000 feet above the earth as on it.

I went back to my seat and took a look at the navigator's calculations. We had a tail wind and were flying at a speed of 500 m.p.h. Smoothly and monotonously, the engines droned on. All the instruments were working accurately.

At 06:37 hours we passed over Gander, slightly ahead of schedule, with 2,600 miles of ocean before us. This was the most difficult stretch for our navigators; below us lay dense cloud, and from time to time we flew through high cirrus clouds. A powerful side wind blew us 15° off course. The navigator made the necessary heading alteration, and we tilted back our seats and relaxed, leaving the autopilot to do the rest.

At 18:33 hours Moscow time we reached Bergen, with the Atlantic behind us; the navigators had risen valiantly to their task. We made frequent alterations in course and kept strictly to the Oslo and Stockholm airlanes.

At last we saw the Baltic and, in the distance, a vast cloud front. In that direction lay the Russian coast. We climbed to 37,000 feet and roared away over the crests of the storm clouds. Shortly before 21 hours (Moscow time) we landed at Vnukovo after a flight lasting 9 hours 48 minutes.

During its one-year test period the Tu-114 made many long-distance flights, including a non-stop flight from Moscow to Khabarovsk in the far east of the Soviet Union. The picture shows the aircraft at Khabarovsk airport.

A.I.A. Annual Forecast

In previous years, forecasts of trends and requirements for the aerospace industry have been published annually by the Aerospace Industries Association of America, Inc. (AIA), formerly known as the Aircraft Industries Association, in the form of brief textual reports. The 1959 forecast is largely a graphical presentation of the main factors affecting the planning of future research and development programmes. Compiled by a number of AIA technical committees representing the aerospace industry, the 1959 report is in two parts, the first covering environmental trends, systems trends, materials and process requirements, and test requirements; part two is a forecast of manufacturing processes, including assembly and joining, metal shaping, plating and cladding, and testing and inspection of electronic equipment.

*

Part one includes the prediction that the major human factor effort during the next ten years will continue to be applied to problems of human escape and survival, with the development of space vehicle escape systems presenting the most difficult problems. The study of human environments will become more important, particularly in all research on space vehicles. Advanced studies on human capabilities and limitations will require slightly less effort than problems affecting either environments or systems, but the more complex aspects of human behaviour, such as taking decisions, evaluating information, or search and detection, will require close attention.

The trend of increasing heat environments created by atmospheric friction as aircraft speeds increase indicates that for continuous flight in the atmosphere during the next decade, aircraft speeds will have to level off at about Mach 4 (2,500 to 2,700 m.p.h.) and that aircraft skin temperatures will then be about 2,000°F (1,100°C).

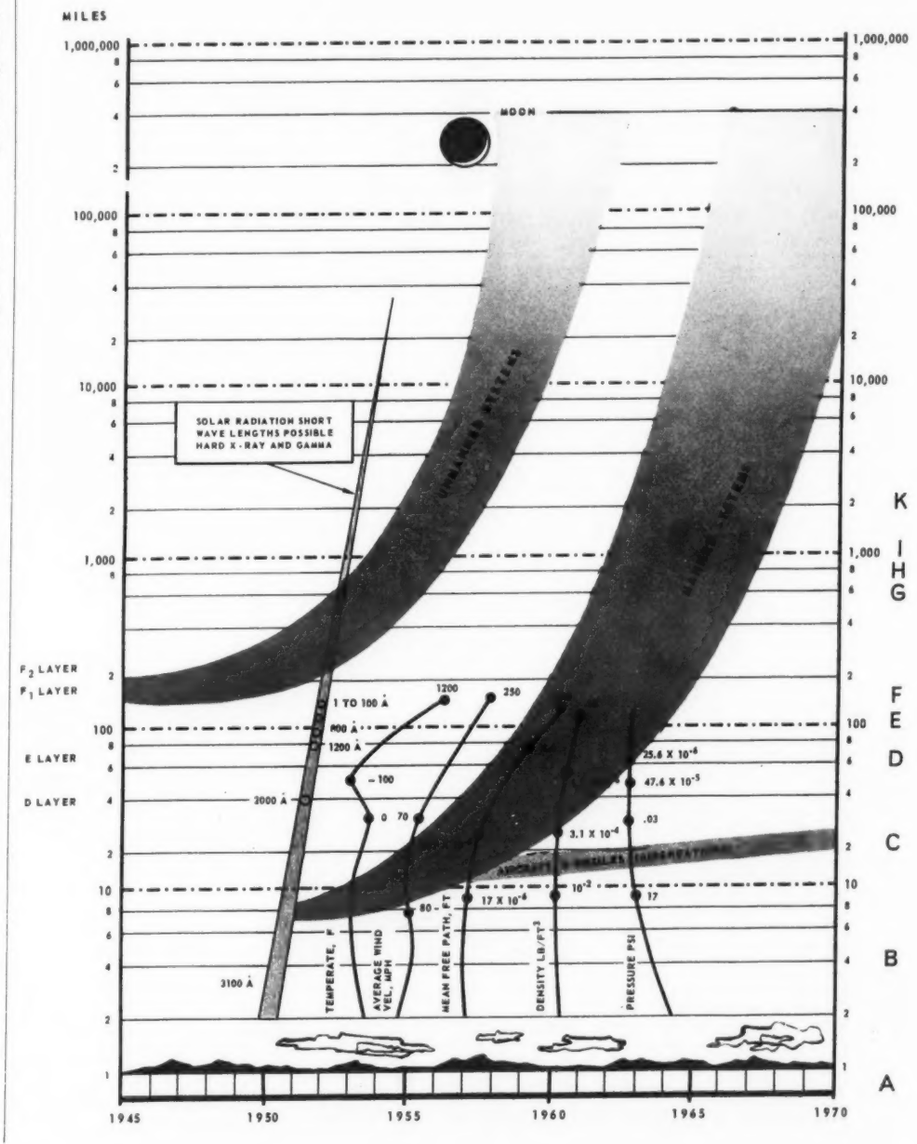
In considering natural environmental trends, electromagnetic radiation becomes an important factor from an altitude of 20 miles upwards, because high intensities of ultra-violet are absorbed by the atmosphere due to the generation of ozone at this distance above the earth. The van Allen belts of radiation partially encircling the earth (at latitudes less than 70°) consist of particle-type radiations of electrons or protons, and further research will be required to assess accurately the extent of this radiation.

A marked increase in the use of inertial guidance and control systems will occur during the

The graph shows the trends in natural environments for unmanned systems, manned systems, airbreathing aircraft and missiles from 1945 to 1970. The distances in miles on the left of the graph are divided as follows: from 1 to 10, atmosphere; 10 to 100, upper atmosphere; 100 to 40,000, terrestial space; 40,000 to 300,000, cislunar space; 300,000 to 500,000, translunar space; and through interplanetary space to interstellar space. Natural environments are: A = Low temperature, corrosion, humidity, sand, fungus etc.; B = Rain, hail and convection currents; C = Maximum cosmic radiation and ozone; D = Lower aurorae; E = Dissociated and ionized gases (nitrogen, hydrogen, helium etc.); F = Micrometeorite dust; G = Approximate lower limit of intense radiation (van Allen high intensity belt); H = Highest sunlit aurorae; I = Interplanetary gas (hydrogen and free electrons); K = Approximate upper limit of intense radiation.

*

Finally, reading from left to right, physical data is given on the following: intensity of high-frequency electromagnetic waves (with wavelengths in Ångströms); temperature in degrees Fahrenheit; average wind velocity in mph; mean free path in feet; density in pounds per cu. ft.; pressure in pounds per sq. in.



next ten years, and there will be a proportionate decrease in the number of non-inertial systems. Doppler-inertial and stellar-inertial systems will be fairly common by 1965 in both second generation missiles and in space vehicles, but systems using celestial mechanics will often be found in the latter by 1970. The use of infra-red guidance systems for manned aircraft will probably increase somewhat and then decline sharply between 1960 and 1970, but infra-red guidance will be more and more common in missiles and space vehicles during the decade under review.

High performance rocket engines depend on the efficient consumption of high energy fuels and, basing the estimate on anticipated fuel developments, thrust efficiency should increase by at least 50 percent by 1970; however, the advent of free radical and airborne nuclear power plants makes a 400 percent improvement possible, and chemically-fueled plant may gradually disappear from 1970 onwards. Ion rockets and photon engines have been studied as possible power units for use in outer space where low thrust, high specific impulse engines can be used effectively. Development of these systems will be accelerated when space flight by both chemical and nuclear powered vehicles becomes more frequent.

*

Part two of the AIA Report forecasts manufacturing processes and procedures during the next decade. Continuing civilian and military developments in the aerospace industry have stimulated a demand for higher manufacturing ability, and it is expected that the new technologies and complex processes of the space age will require greater educational and technical specialization to produce the advanced weapons concepts that the industry foresees.

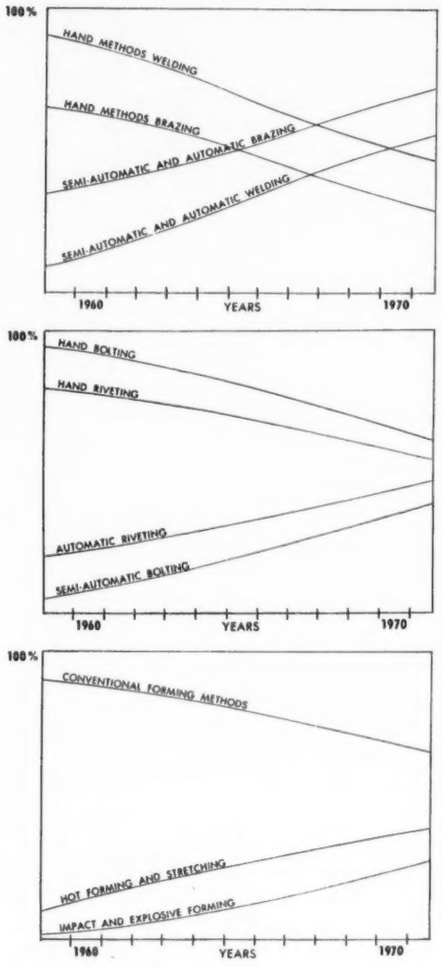
The delay between the design stage and series production is growing shorter and, if this desirable trend is to be maintained, better manufacturing methods, improved equipment and more complex tools must be developed. A variety of manufacturing problems will arise when new materials come into more common use.

Some machining now performed at room temperature will have to be carried out with materials and/or tools super-heated or at extreme sub-zero temperatures because some of the new metals and practically all of the ceramics cannot be machined with ordinary tools. Some of the new tools will have to include ultrasonic or electrical discharge machining, and manufacturing equipment in general is becoming so precise in relation to its product that highly specialized semi-automatic and numerically controlled machine tools will be mandatory.

Trends indicate that considerable progress will be required in plating, coating and cladding, and in the development of automatic systems to control these processes. Plating and, where necessary, cladding should be combined with joining processes for secondary structures where the temperature characteristics of these operations allow.

The chance for human error in manufacturing techniques will have to be completely eliminated and, as a result, extremely complex testing procedures will be recorded on tape and evaluated automatically. Trends in automatic testing systems are towards memory drums and data storage devices that will be able to compare information and decide which solution is the most satisfactory. When advanced electronic equipment of this kind is in more general use, manufacturing processes will be more accurate, and the finished product will be more reliable.

The 1959 Forecast is the sixth annual report of this kind prepared by the AIA for distribution to the United States Department of Defense, other government agencies, and all industries serving the aerospace complex. The report is based on information supplied by member companies of AIA and was compiled by the Research and Testing Committee, and by the Manufacturing Equipment, Tooling and Test Committees.



These three graphs show the main trends in assembly and joining, and materials shaping, for the next ten years. From above: 1. curves for manual, semi-automatic and automatic welding and brazing; 2. manual bolting and riveting, automatic riveting and semi-automatic bolting; 3. conventional methods of shaping materials, hot forming and stretching, impact and explosive forming.

Book Reviews

Flieger erobern die Welt. Das Grosse Buch der Luftfahrt. Edited by Kurt W. Streit. Union Verlag, Stuttgart 1958 (German; 292 pages; price DM 7.80).

Fourteen skilled German aviation writers have here presented an entertaining history of the world's successful pilots, in the form of short, representative episodes; the Wright Brothers, Blériot, Lindbergh, Köhl, Hünefeld, Fitzmaurice, von Gronau, Freiherr von Gablenz, Mermoz, Yeager ... these are only some of the famous names mentioned, and the book gives only a small sample of the names which have gone down in aviation history. The aim has not been to present a complete picture, but merely to select examples of men who have given their all to the common effort. In the last chapter but one ("Between Yesterday and Tomorrow") the author takes the reader on a tour of the Lockheed plant and gives him a glimpse behind the aircraft manufacturing scene, while the final chapter describes an imaginary trip in space. Pleasant reading.

He.

Applied Hydrodynamics. — By H. R. Vallentine. — Published by Butterworths Scientific Publications London, 1959. (English, 272 pages; price 50 shillings)

The science of hydrodynamics is often the starting point for advanced studies of fluid mechanics, and many theoretical treatises have already been published on the subject. In the past, however, there has been a tendency to concentrate on theory and this book differs from previous texts by reversing the process and emphasizing practical applications rather than theoretical analysis. It is intended for use in universities as an introduction to hydrodynamics, or as an advanced course in fluid dynamics for senior and post-graduate students in aeronautical, civil and mechanical engineering. Students interested in this branch of applied mathematics will find a clear approach to such subjects as turbulent flow and the boundary layer, flow patterns, viscosity, conformal transformation, and three-dimensional irrotational flow.

Pe.

Taschenbuch für Atomfragen 1959. — Edited by Dr. W. Cartellieri, Dr. A. Hocker and Dr. W. Schnurr, all of the Federal Ministry for Atomic Energy and Water Power. — Festland Verlag, Bonn, 1959 (German; 300 pages thin paper; pocket format; plastic cover; price DM 9.50).

The first authentic reference book on the peaceful uses of nuclear energy and the problems of radiation protection in the German Federal Republic. Seventeen contributors describe clearly but with scientific accuracy the structure of Germany's nuclear energy organization and attendant research and training. The more important aspects of international cooperation are also covered. Tables of German research reactors, training establishments and measuring stations supplement the text. In short, the atomic pocketbook is indispensable for politicians, economists, scientists, administrative experts, public relations officials and the ordinary citizen interested in atomic questions.

Wz.

Mars Revisited. — By Donald L. Cyr. Illustrations by Arthur D. Beeman. Published by Dorrance and Co., Philadelphia (English; 131 pages; price 3 dollars).

With a rose-coloured telescope held firmly to his eye, the author of this amusing little book has carefully blended serious comment with fantastic conjecture, to the point that the reader is never quite sure whose tongue is in whose cheek. It is, for instance, comforting to learn that the Marsitron can be defined as an animate particle whose characteristics have yet to be determined, but less reassuring to find that he, she, or it probably commutes between house and feeding grounds at speeds of over 60 m.p.h. Mr. Cyr has produced a novel explanation of the mysterious linear patterns on the surface of Mars and the portrayal should at least be as stimulating to the imagination as those famous slithy toves that did gyre and gimbal in the wabes. In fact, this book might well provide a satisfying liqueur after an indigestible repast of grilled Yeti and moonshine salad.

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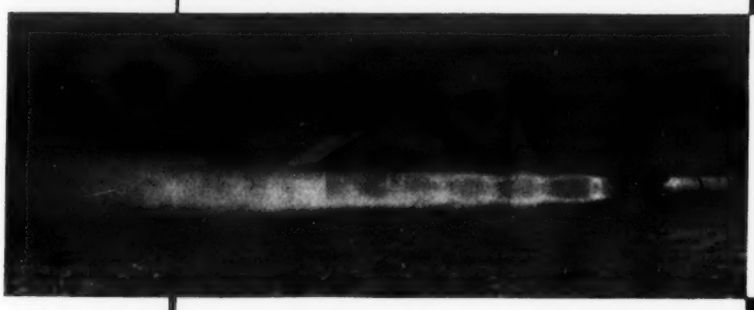

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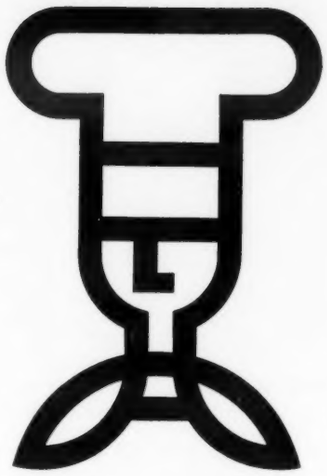

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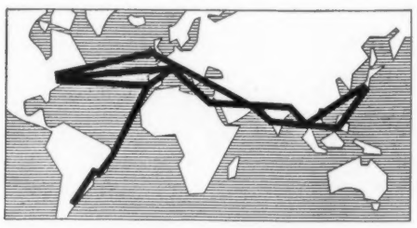

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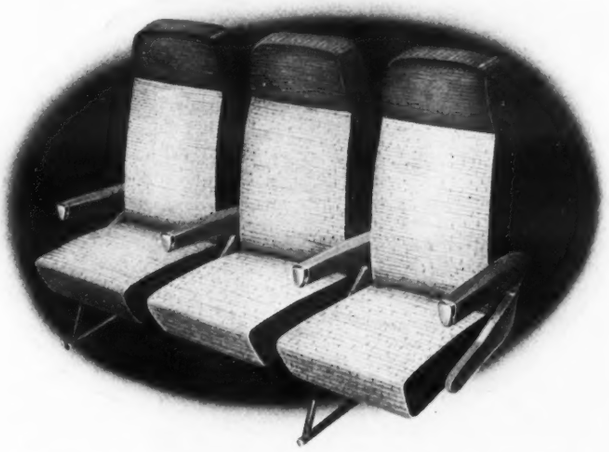

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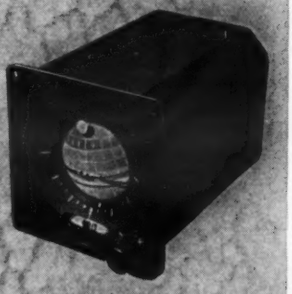

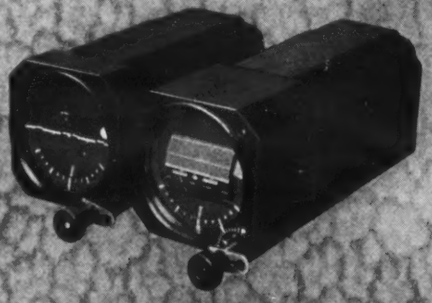

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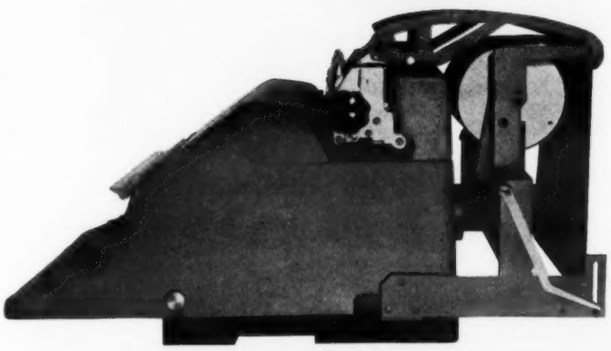

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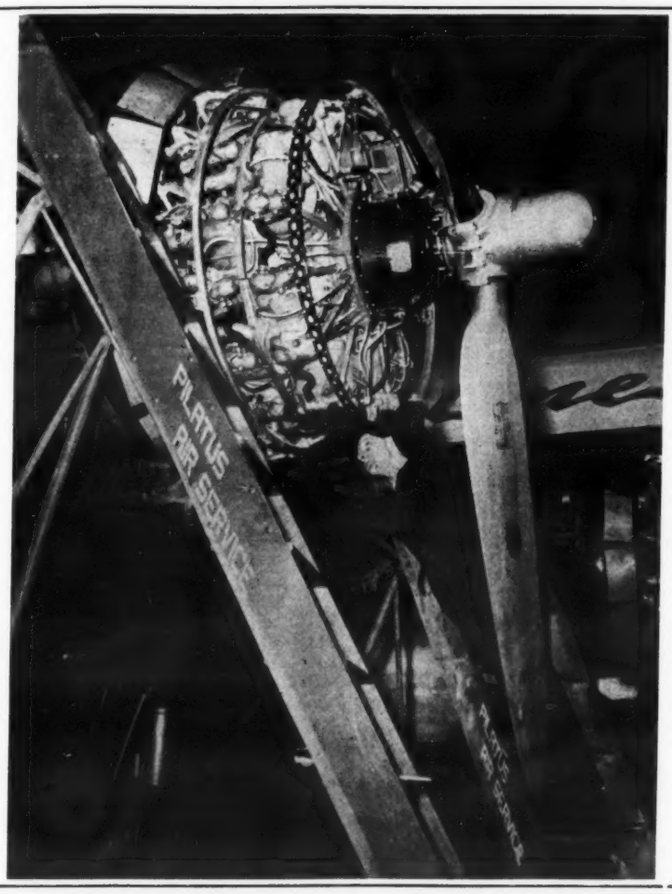

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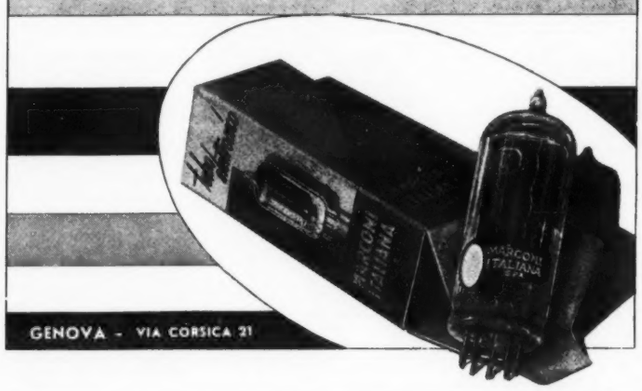

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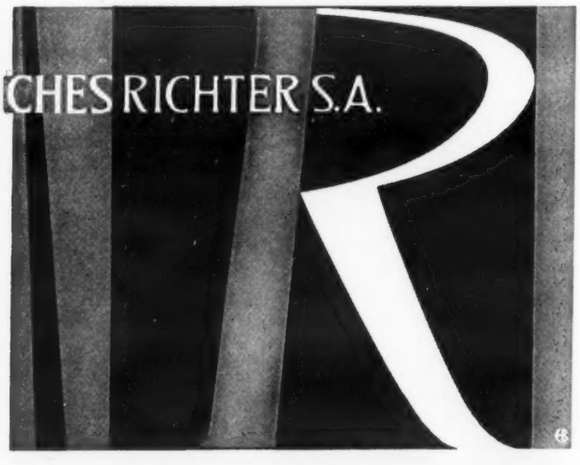

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